COLLEGE OF ENG

the Cornell

OCTOBER, 1954

VOL. 20, NO. 1

25 CENTS

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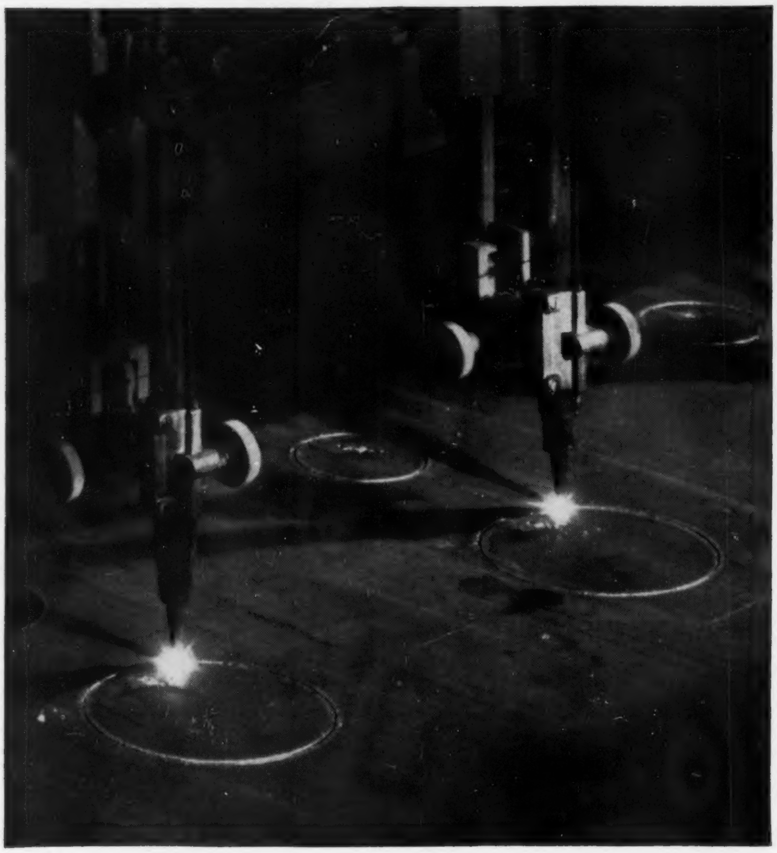

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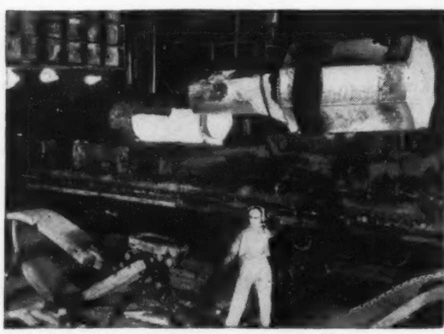

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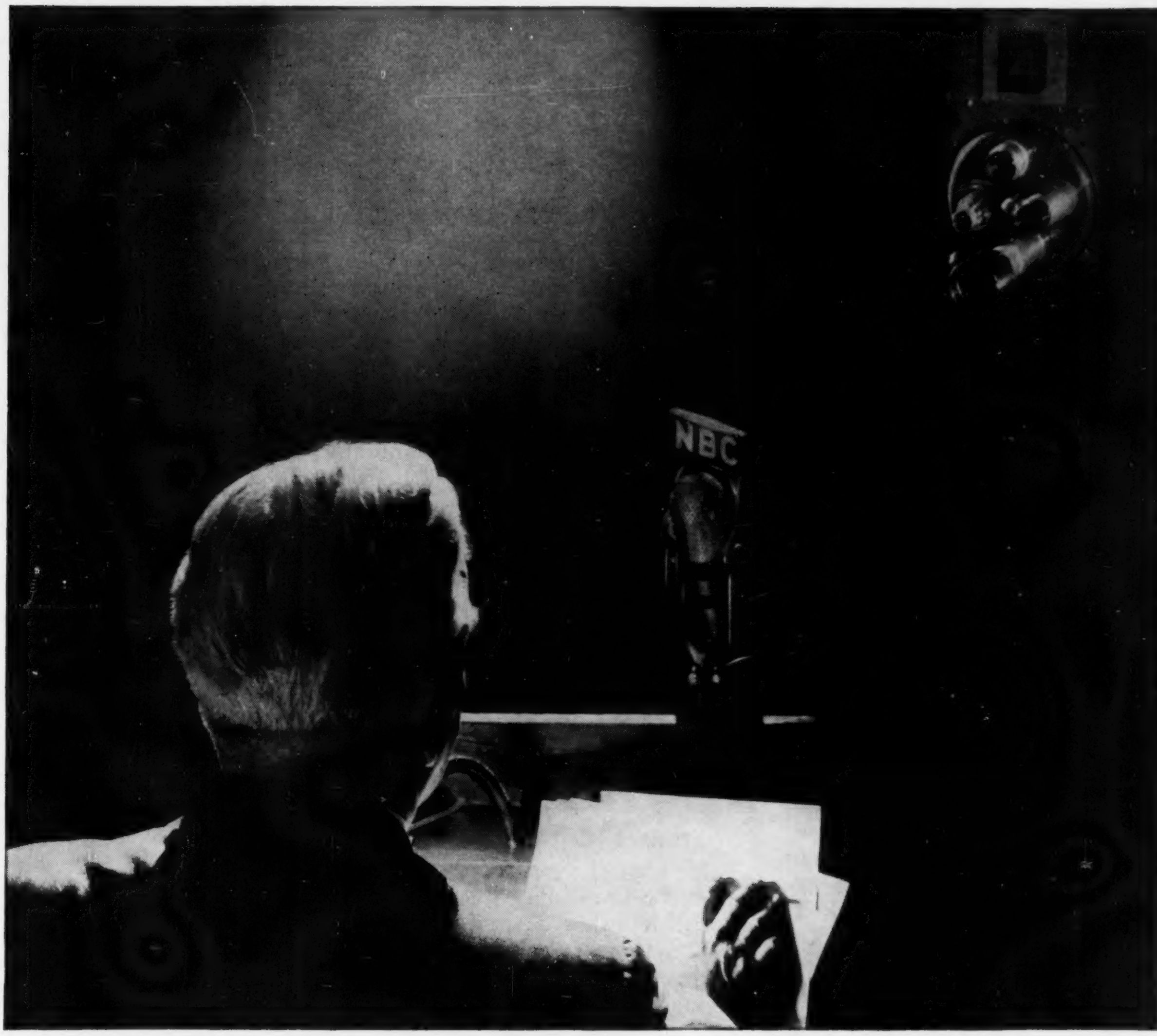

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Write today to College Relations Div., RCA Victor, Camden, N. J. Also many opportunities for Mechanical and Chemical Engineers and Physicists.

From the Dean

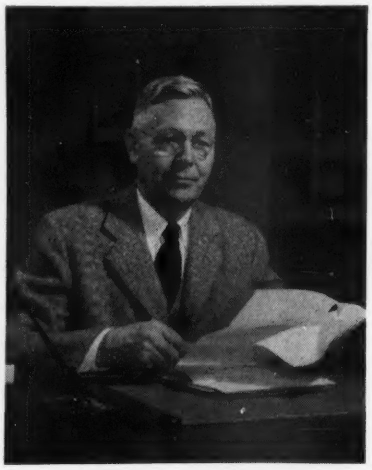
It is a pleasure to welcome you to Cornell as members of the Freshman Class in Engineering.

I am sure you realize that you are entering now the most important period of your preparation for a lifetime career. The direction and shape of your future very likely will be determined to a considerable extent in your next five years at Cornell — five years which constitute the most productive investment you can make for a successful career. I cannot urge you too strongly to keep in mind that in this time you must establish a foundation upon which you can build a professional life for forty years or more.

Looking this far into the future, to what pattern shall we plan your engineering training? The answer to that lies in the recognition that the engineer is no longer a highly individualistic, specialized technician. He is a professional man in every sense of the word, skilled both in the use of science for the solution of broad technological problems, and in the application of rational analysis to economic, social, and business affairs. So it is that, whatever your immediate field of interest may be now, you will probably find that your career will call you into many activities you cannot now anticipate.

You will find also that your scholastic training must have such firm roots that whatever advances in engineering may come about — and certainly such advances are occurring with increasing rapidity — you will have the background that will enable you to advance your own abilities with the growth of the profession, and in fact provide the leadership for that growth. This has been the Cornell tradition.

A final objective you must have in mind throughout your college career is this: that both through your formal study and your many activities outside the classroom you will accept the stimulation that is all about you for broad intellectual growth, so that you will be prepared to take leadership as a citizen in the whole range of human affairs as well as in your professional work.



Dean S. C. Hollister

In order to benefit fully from your association with Cornell, you should endeavor to become familiar with its distinctive personality and its historical development. There is much inspiration in the story of Cornell and I hope you will seek it out. You will find, for example, that at its beginning, Cornell represented a radical departure from the classical concept of higher education which would not tolerate the practical sciences as fit subjects for major study at this level. Ezra Cornell himself determined that training in engineering, science, and the humanities should stand side by side here, each benefiting from the others.

So it was that, within a very short time, Cornell engineers were taking a dominant part in the great industrial development and the great advances in transportation and communcation which began about that time. This traditional role of the College continues to the present time. You will see around you the physical evidence of our planning for the future, with a number of new engineering buildings in use or under construction. Of even greater importance, however, is the Cornell of human beings, human ideas, and human enthusiasms. Your full participation in this fraternity will establish the return on your investment.

The engineering curricula at Cornell provide a superior educational preparation, second to none. They are designed to train for leadership and as such they are demanding of our best mutual efforts. I can assure you that we are determined to work with you in every way possible to bring about the most effective kind of educational experience.

It would be unrealistic, however, to expect that the path will be smooth and troublefree for all. It is likely to be the most challenging you have ever attempted, but by the same token also the most rewarding. For some the adjustment of these first few weeks may be difficult and perhaps even momentarily discouraging, but I want you to know that we stand squarely behind you, asking in return your own sincerity of purpose. You have been chosen for the engineering program at Cornell on the basis of a highly selective admission procedure. We think you can become a Cornell Engineer, and our every effort is directed toward having you take your place in this distinguished family.

In urging you to your maximum effort I do not intend to sound an unnecessarily stern note. This is a joyous occasion and the beginning of one of the most happy and fruitful periods in your life. The opportunities for your personal development will be almost limitless. Cornell is a spiritual as well as an intellectual experience and I hope that you will take full measure of all that is here.

I congratulate you on the opportunity before you.

S. C. Hollister

ENGINEERS

or

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To those interested in advanced academic study while associated with important research and development in industry, Hughes offers two separate practical programs:

HUGHES COOPERATIVE FELLOWSHIP PROGRAM

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A program to assist outstanding individuals in studying for the Master of Science Degree while employed in industry and making contributions to important military work. Open to students who will receive the B.S. degree in Electrical Engineering, Physics or Mechanical Engineering during the coming year, and to members of the Armed Services honorably discharged and holding such B.S. degrees.

Candidates must meet entrance requirements for advanced study at the University of California at Los Angeles or the University of Southern California. Participants will work full time during the summer in the Hughes Laboratories and 25 hours per week while pursuing a half-time schedule of graduate study at the university.

Salary is commensurate with the individual's ability and experience. Tuition, admission fees and books for university attendance are provided. Provision is made to assist in paying travel and moving expenses from outside Southern California.

HOW TO APPLY

for the Hughes Cooperative Fellowship Program: Address all correspondence to the Committee for Graduate Study

THE HOWARD HUGHES FELLOWSHIPS

in Science and Engineering

Eligible for these Fellowships are those who have completed one year of graduate study in physics or engineering. Successful candidates must qualify for graduate standing at the California Institute of Technology for study toward the degree of Doctor of Philosophy or post-doctoral work. Fellows may pursue graduate research in the fields of physics or engineering. During summers they will work full time in the Hughes Laboratories in association with scientists and engineers in their fields.

Each appointment is for twelve months and provides a cash award of not less than $2,000, a salary of not less than $2,500, and $1,500 for tuition and research expenses. A suitable adjustment is made when financial responsibilities of the Fellow might otherwise preclude participation in the program. For those coming from outside the Southern California area provision is made for moving and transportation expenses.

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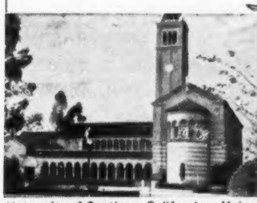

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From the Engineer

The staff of THE CORNELL ENGINEER takes great pleasure in welcoming both the new and old students back to Cornell for the 1954-55 school year. With the beginning of school, many readers will again receive THE CORNELL ENGINEER; therefore, this seems an opportune time to acquaint you with the history and present operations of the magazine.

The history of THE CORNELL ENGINEER dates back to 1887 and the publication of *The Crank*. This monthly magazine, published by engineering undergraduates, consisted of one or two short technical articles supplemented by an alumni section, an editorial page, and a college news section which covered the latest events in the rapidly expanding Sibley College. The first copy of *The Crank* included an article by Alexander Graham Bell entitled "The Telephone and Photophone".

In 1892, after five years of successful publication, *The Crank* changed its name to *The Sibley Journal of Engineering*. In 1892 a second engineering publication appeared on the campus when the revived Association of Civil Engineers presented the first volume of *Transactions of the Association of Civil Engineers of Cornell University*. The *Transactions,* which included a list of association members and lecturers and a variety of technical papers, was replaced in 1907 by *The Cornell Civil Engineer*. In the succeeding years both *The Sibley Journal* and *The Civil Engineer* gained wide recognition for their fine technical articles and editorials. These articles, some written by such prominent men as R. H. Thurston, W. F. Durnad, E. L. Nichols, and H. J. Ryan, led to the award of a "Grand Prix" to *The Sibley Journal* at the Paris Exposition of 1900. In 1913 *The Civil Engineer* was commended for its excellence by *The McGraw Engineering Record.*

In 1916 the pressure of World War I forced *The Sibley Journal* to offer premiums with its subscriptions. Incentives ranging from Starrett speed indicators to records by the Cornell Glee Club were given away on payment of the $2.00 subscription price; however, through reduced circulation and the loss of accumulated profits, both *The Sibley Journal* and *The Civil Engineer* were forced to suspend publication in 1918. After World War I, both magazines resumed operations on a scale surpassing their prewar efforts. *The Civil Engineer* introduced a contribution box for the purpose of giving the magazine a human touch.

Plans for the merger of the various technical publications of the University began before World War I. In 1915 the merger of *The Civil Engineer* and *The Sibley Journal* was proposed, and in the same year the combination of *The Civil Engineer, The Sibley Journal,* and two contemporary publications, *The Cornell Chemist* and *The Cornell Architect,* under one editorial board was also suggested. Since no merger plan could be found that was acceptable to all the magazines, both these suggestions were dropped until after World War I. Plans for the merger of *The Sibley Journal* and *The Civil Engineer* were unsuccessful largely because of the opinion of the staff of *The Civil Engineer* that a union would restrict its editorial format to technical articles at the expense of alumni reader-interest. The Depression, which forced *The Sibley Journal* to consider suspension and reduced the circulation of *The Civil Engineer* to 37, finally made merger a necessity, and in October of 1935 the two publications finally combined to yield THE CORNELL ENGINEER. Final arrangements for the merger were largely the result of the efforts of Professors Hollister and Diedrichs.

THE CORNELL ENGINEER possesed an advantage over its predecessors in that it had greater production economy and a greater ability to present the news and work of the College of Engineering to Cornell students and alumni. In the years that followed the merger, THE CORNELL ENGINEER continued publication without cessation, including the period during World War II.

Today the purpose of THE CORNELL ENGINEER is to provide better communication between the students, faculty, and alumni and the College of Engineering, and to present articles of general technical interest to undergraduates, faculty, alumni, and outside readers alike. To acomplish this purpose, THE CORNELL ENGINEER includes in its various issues at least three articles of general technical interest, a faculty profile, an alumni section, a short section on recent technical developments, editorials, news of the College of Engineering, a service section, a humor section, and various short features.

Through the Engineering College Magazines Associated, ECMA, THE CORNELL ENGINEER procures advertising and receives a monthly critic's report which criticizes the magazine and suggests improvements for later issues. The ECMA also afford THE CORNELL ENGINEER better communication with engineering publications in other member engineering schools throughout the country, and in this manner promotes the exchange of ideas and solution of mutual problems.

The staff of THE CORNELL ENGINEER wishes its readers success in the coming year and hopes that they will enjoy the articles appearing in the magazine.

Croesus' cavalry stampeding at the sight of Persian camels

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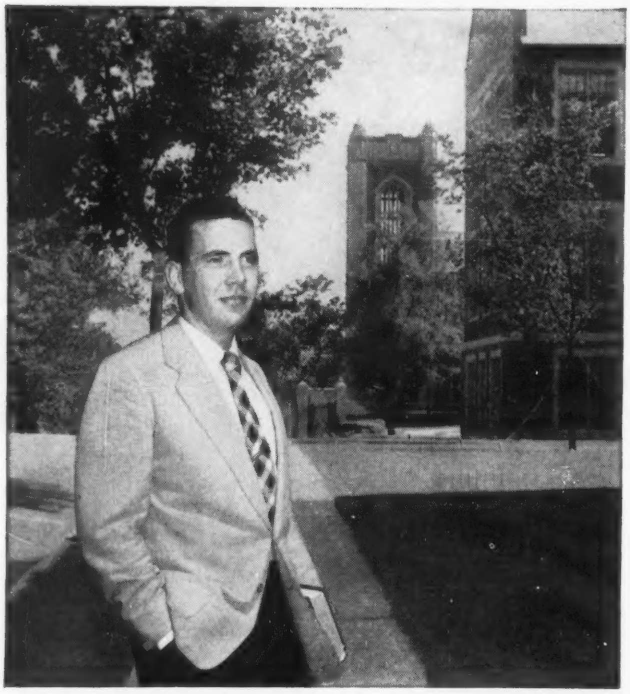

Donald W. Sundstrom received his B.S. degree in Chemical Engineering from Worcester Polytechnic Institute in 1953. He's currently studying for an M.S. degree and expects to receive it next year. Like other engineering students, he's asking a lot of searching questions before deciding on a permanent employer.

Don Sundstrom asks:

What are my chances for advancement in a big firm like Du Pont?

Gerald J. Risser, B.S. Chem. Eng., Univ. of Wisconsin (1937), is now assistant manager of the Engineering Service Division in Du Pont's Engineering Department, Wilmington, Delaware.

Jerry Risser answers:

I THINK I know exactly what's behind that question, Don, because the same thing crossed my mind when I first graduated and looked around for a job. That was about seventeen years ago, when the Du Pont Company was much smaller than it is today. And there's a large factor in the answer, Don, right there! The advancement and growth of any employee depends to a considerable degree on the advancement and growth of his employer. Promotion possibilities are bound to be good in an expanding organization like Du Pont.

Right now, for example, construction is in progress or planned for three new plants. That means many new opportunities for promotion for young engineers. And, in my experience, I have found it is a fundamental principle of Du Pont to promote from within the organization—on merit.

My own field, development work, is a natural for a young graduate, because it's one of the fundamental branches of engineering at Du Pont. There are complete new plants to design, novel equipment problems to work on, new processes to pioneer—all sorts of interesting work for a man who can meet a challenge. Many of the problems will involve cost studies—some will require evaluation in a pilot plant—but, in every case, they'll provide the satisfactions which come from working with people you like and respect.

All in all, Don, your chances of advancement on merit are mighty good at Du Pont!

Want to know more about working with Du Pont? Send for a free copy of "Chemical Engineers at Du Pont," a booklet that tells you about pioneering work being done in chemical engineering—in research, process development, production and sales. There's a step-by-step outline of the leadership opportunities that confront a young Du Pont engineer—how he can advance—and how he can obtain help from experienced members of the team. Write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware.

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COVER—Cornell Bear holds Princeton Tiger at bay.
—*Alan Cohen*

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STOP
TANK CAR
CONNECTED

TRANSPORTATION OF CHEMICALS

by SACHIYUKI MASUMOTO, Chem.E. '54
and MORTON LOWENTHAL, Chem.E. '54

Photographs Courtesy of Dow Chemical Corporation

The science of packaging and transporting safely the products of the chemical works, industrial explosive plants, and petroleum refineries has kept pace with the achievements of the industry. This has proved to be an important development, since no other segment of the economy has a greater impact on the average company's costs and profits.

In undertaking to develop and recommend packages and shipping practices applicable to its dangerous products, the chemical industry has recognized its obligation to all concerned by placing safety above all other considerations. The safe transportation of hazardous articles by the millions of tons annually has not come without diligent effort, research, and cooperation on the part of carriers and shippers, aided by the regulations prescribed by interested regulatory agencies.

The most influential regulation pertaining to the shipment of chemicals is titled "Interstate Commerce Commission Regulation for Transportation of Explosives and Other Dangerous Articles by Land and Water, in Rail Freight Service and by Motor Vehicle and Water, including Specifications for Shipping Containers". These up-to-date regulations stem from an Act of Congress in 1908 designated "An Act to Promote the Safe Transportation of Explosives with industry has Articles and to Provide Penalties for Its Violation". Effective cooperation of the Interstate Commerce Commission and the Bureau of Explosives with Industry has given fair and practicable regulations which have effectively kept accidents to a minimum while providing for efficient transportation.

Transportation as a whole is a growing industry, but not a growth industry. The industry's volume of business is expanding as fast as the national total of goods and services—but no faster. At the same time its share of the nation's sales dollar has been going down. Ever since 1932 transportation's share of national sales has been dropping and it is now the lowest in history.

This lag in sales is only relative, however, and means only that transportation is getting a smaller part of a much larger overall business. Cheaper transportation is fine with the transportation companies, as well as the shipper, as long as it is gained by increases in efficiency. It is to this end that the methods of transportation have taken on a new look.

Trucks being loaded from tank car.
—*Dow Chemical*

Transportation by Railroad

About the middle of the nineteenth century, the petroleum industry made the first bulk rail shipment of "chemical" raw materials; the first tank cars were simple wooden vats or tubs with no special arrangement for loading or unloading. The first improvements in the transportation units were the result of the development of the internal combustion engine and its requirement for gasoline.

The need of the special tank cars for transportation brought up the question of who should furnish them—the oil companies said the railroads should supply the proper car, and the carriers claimed that the financial burden of having a wide variety of cars was too excessive and not within the common law responsibility as a public carrier. The Interstate Commerce Commission decided in favor of the railroads, but in doing so, it prescribed the freight rates for the commodity being shipped and allowed a two-cent mileage allotment for standard tank cars, with higher allotment for special cars.

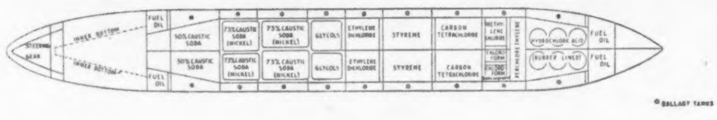
When a new commodity is to be shipped by rail, the I.C.C. must first approve the material for shipment, then establish definite regulations covering its transportation. The builder or leaser of the car then applies to the Association of American Railroads for the approval of the particular type of car designed for the new commodity. Precautionary regulations concerning the safety of personnel and the careful shipment of the commodity without damage or contamination are then established.

The vapor-pressure-temperature relationship of the commodity is the principal factor in determining the type of car used for its shipment. The regulations define compressed gas as any commodity with a gauge pressure over 25 psia at 70° F or any inflammable liquid material having a Reid vapor pressure exceeding 40 psia at 100°F. The majority of the materials are not covered by the definition of compressed gas and hence are shipped in tanks with an expansive dome. The materials that are covered by the definition are then classified by their vapor pressures at 105°C or 130°F.

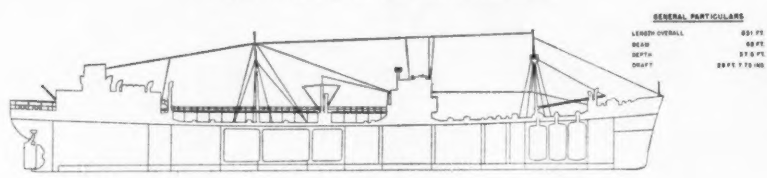
The tank car, in its simplest form, is a horizontal tank on a wheeled carriage. Variations of this simple horizontal tank are used to transport over 500 different products, including liquids, slurries, greases, sludges, gases, and free-flowing solids. There are 29 classes of tank cars listed by the Association of American Railroads; the different classes vary in material of construction, loading and unloading methods, safety valves or vents, tank construction and pressure rating, insulation, etc.

The "general service cars" with capacities of 8,000 or 10,000 gallons are the most common type. These cars are constructed of open hearth steel or boiler plate steel of flange quality, with or without compartments, may be lined with a plastic coating. If the car is thoroughly and properly cleaned after carrying one commodity, it can be used to haul some other material.

A TYPICAL MARINE DOW-CHEM CARGO



A CROSS SECTION OF THE MARINE DOW-CHEM



The tank cars are generally loaded through the top by swing pipes. They are unloaded either by gravity through a bottom outlet or by connecting a dip pipe through the dome to the bottom of the tank, and the commodity is forced out via this dip pipe by air pressure introduced into the tank via a dome connection.

There are a relatively small number of special tank cars. The shipment of certain chemicals may require a special material of construction; these tanks cars may be made of aluminum, stainless steel, or clad with nickel or stainless steel, or lined with rubber. In a second type of special car, the plate thickness may vary in different parts, and may be equipped with safety valves or safety vents.

Special linings of rubber and phenolic or vinyl type resins are often used. Rubber linings cost $2000 to $2800 per car, but give protection for more than three years. The lining is applied by putting on 5 to 7 coats of synthetic resin paint, and baking or curing the resin, if required, by introducing hot air or superheated steam into the car. The use of protective linings is expected to grow as improvements are made in the field of synthetic resin base paints.

An important class of special tank cars is the insulated tank car. These cars may be used to prevent chemical breakdown or bacteria contamination of some commodities by either heat or cold, prevent buildup of pressure of compressed gas in a single unit tank, or maintain the shipment in a liquid state. The insulation may be fiber glass in blankets, or 12″ x 36″ x 4″ rectangular blocks of cork cut at an angle to fit the circumference of the car. The car may also have internal or external heating coils for either steam or oil as an added protection for ease of unloading at its destination. An example of this type of car is that used to haul liquid sulfur. The sulfur, freezing point of 245°F, is loaded at 300°F into a tank car with 4-inch fiber glass lagging, and equipped with steam coils as a safety measure.

Another special type of tank car is the pressure car which is generally limited to 60,000 pounds per load. An exception to this rule is that used to transport chlorine; these cars are 16-, 30-, or 55-ton cars. The chlorine tank car has two gas and two liquid valves besides a safety valve in the dome; the liquid valves are connected to dip pipes that go to the bottom of the car. The car is loaded by pumping liquid chlorine against a gaseous chlorine pressure and is unloaded by introducing gaseous chlorine and forcing liquid chlorine up the dip tubes. The car has a 4-inch cork insulation.

Most solid materials are transported in covered hopper cars, which are simply two or more covered bins on a railroad carriage. These bins are loaded from the top through manholes and are unloaded through the bottom by gravity or a vacuum. These cars have capacities of 1300 to 3000 cubic feet, depending on the density of the material. These hopper cars may also be clad with nickel or stainless steel, or painted with a varnish or plastic resin solution to prevent the pickup of small amounts of iron in the commodity,

The present trend of the car manufacturers is toward both larger and smaller tank cars—the larger for the large users of basic chemicals, and the smaller toward the use of smaller users of basic chemicals and specialty chemicals. There is also an increase in the number of cars for special items.

Cargo ship can be seen with pipe network that carries chemicals to loading point.

Transportation by Trucks

The chemical shipper's first acquaintance with the tank truck industry was through the occasional use of tank truck equipment made to haul gasoline and other products. Moreover, the chemical shipper found that the tank truck operators not only had the equipment, but were already familiar with the problems of bulk liquid transportation.

An added stimulus to the tank truck operators was the order during World War II which limited the use of tank cars to hauls of 200 miles or more. The shippers began to consider special equipment for trucks to handle bulk liquids and found the operators willing where the volume of business justified the expense.

Chemical hauling started as a part of petroleum transportation, but now states with considerable chemical transportation activity form a solid belt from the Atlantic seaboard to the Mississippi, north of the Ohio and Potomac rivers. The states immediately to the south and west of this area are also quite active, but there is much less activity west of the Mississippi.

In the shipment of materials, the shipper lists the commodities and properties, quantities, origin and destination, hours of loading and unloading, and any special equipment that may be required. The carrier in turn has a list of equipment available, linings and materials of construction, special valves and equipment for producing and maintaining pressure and temperature, the length of time for the haul, and other services available—especially experience in problems of transporting hazardous bulk liquid commodities.

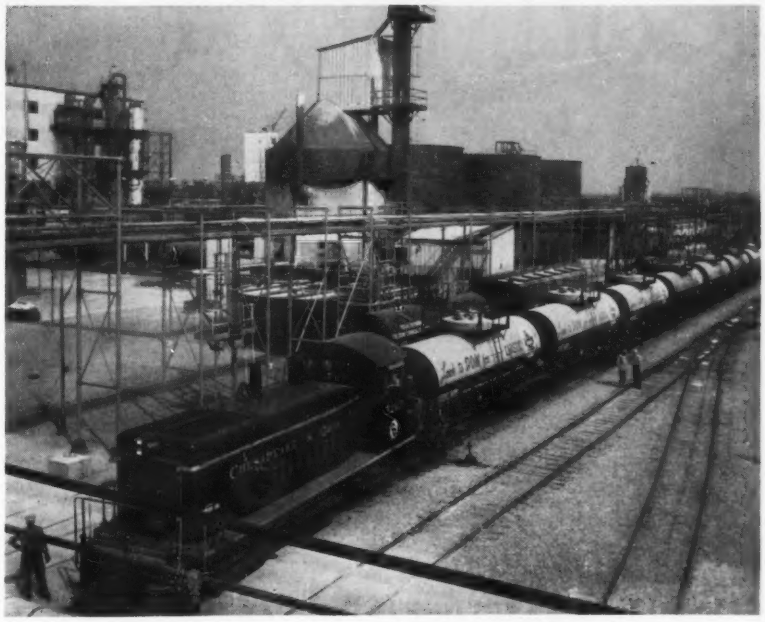
Moreover, the activities of for-hire trucks operating in more than one state are regulated by I.C.C. who issues regulations and supplies new or broadened authority for the bulk of transportation of chemicals.

A considerable initial investment is required to enter the field of bulk chemical transportation. The tank trailers are usually limited to one or only a very few products. The variation in the density of the various comodities and strict weight limitations on trucks in most states make it necessary to have a range in size of trucks to make hauling of the wide range of weights practical, for it is impractical to haul a load when the truck is not full.

The drivers of these trucks are thoroughly trained in the handling of the commodities and are qualified to unload the transport. The drivers are usually sent to the plants themselves to study the characteristics of the chemicals and the precautions necessary for loading and unloading them, and what to do in cases of emergency.

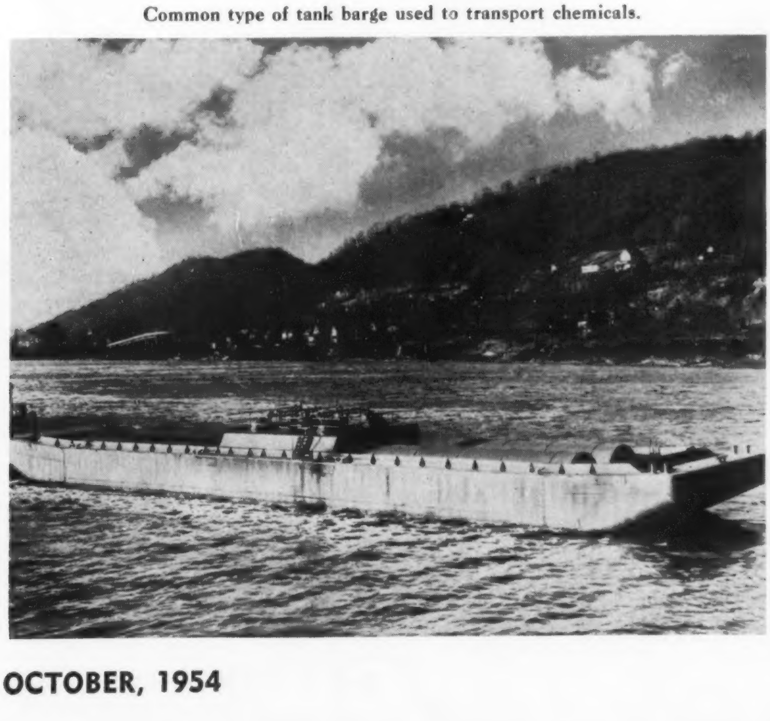
The mechanics not only repair and maintain the motor, but also are trained in the maintenance of the special tanks and valves and in the proper cleaning of the tanks. The tanks are cleaned thoroughly; many tanks are equipped with extra large manholes to enable a man to enter for inspection.

(Continued on page 48)



Tank cars in loading position at switching yard.

Common type of tank barge used to transport chemicals.



QUARTZ CRYSTALS

How a 1¼ hour "gem-cutting" operation became an 8-minute mechanized job

PROBLEM: Preparing quartz crystals for use as electronic frequency controls calls for the highest degree of precision. So much so, in fact, that prior to World War II skilled gem-cutters were employed to do the job.

But during the war, there were not enough gem-cutters to keep up with the demand for crystals in radar, military communications and other applications.

Western Electric tackled the job of building into machines the skill and precision that had previously called for the most highly skilled operators.

SOLUTION: Here is how quartz crystals are made now—by semi-skilled labor in a fraction of the time formerly required:

A quartz stone is sliced into wafers on a reciprocating diamond-edged saw, after determination of optical and electrical axes by means of an oil bath and an X-ray machine. Hairline accuracy is assured by an orienting fixture.

The wafers are cut into rectangles on machines equipped with diamond saws. The human element is practically eliminated by means of adjustable stops and other semi-automatic features.

The quartz rectangles are lapped automatically to a thickness tolerance of plus or minus .0001". A timer prevents overlapping. Finally, edges are ground to specific length and width dimensions on machines with fully automatic microfeed systems.

Most of these machines were either completely or largely designed and developed by Western Electric engineers.

RESULTS: With skill built into the machines —with costly hand operations eliminated— this Western Electric mechanization program raised production of quartz crystals from a few thousand a year to nearly a million a month during the war years. This is just one of the many unusual jobs undertaken and solved by Western Electric engineers.

Quartz stones are cut into wafers on this diamond-edged saw, with orientation to optical axis controlled by fixture. This is just one of several types of machines designed and developed by Western Electric engineers to mechanize quartz cutting.

Western Electric

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E R Quesada

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Vice President and
General Manager

Equity and the Engineer

by SANDER L. WISE, C.E. '54

There can be no doubt that the engineer of today is aware of the importance of the many auxiliary services upon which he must call, and of the extreme importance of this inter-professional cooperation in realizing the large scale technological ventures of the age. He knows that before any public works or large private construction project can materialize, it will require the efforts of architects, engineers, accountants, salesmen, attorneys, and many other specialists. The awareness is evidenced by the growing significance attached to the teaching of administrative subjects in our technical schools and by the trend of industries to seek engineers and other professional men for top level positions in management. It follows in logical sequence that in a situation involving a great many seemingly unrelated specialists, those who would coordinate the individual efforts must be capable of a broad understanding of the effects of each upon the other. One need not stretch logic too far to see that in a fundamentally technical project, it is often the engineer who faces this great problem of coordination.

From the writer's limited experience in construction planning and technical and legal training, it appears that the need is great for a mutual understanding between engineer and attorney—they are often the first to be called upon and are most likely to be intimately connected with each phase of the project from conception to completion. Each must rely upon the other's judgment, and each must base his plans and schedules, in part at least, upon the advice of the other.

Undoubtedly, experienced professional men are aware of this situation and the likelihood is great that successful engineers in the public works or private construction fields do have a limited but useful knowledge of law as it effects their work. Upon this premise the question may be fairly asked, "Why write for engineers on the subject of equity, which is known to be a rather particular and limited kind of jurisprudence?"

This paper is concerned with equity because it *is* a particular and limited field in the law. The writer believes that its potential importance to the engineer is of far greater dimension than has heretofore been recognized; that it is a subject of which those outside the legal profession have little or no understanding; and that its growing importance in law, particularly as related to contracts, is worthy of note by engineers and laymen as well.

Equity—A Form Of Growth

As professional men, we know that there are always novel and unsolved problems waiting upon study and research for solution. In engineering, professional growth is achieved by such study and by the incorporation of results of these studies into practical application. The wheels of progress often turn very quickly as in the case of Professor Cross' method of Moment Distribution. Intermediate structural design may be said to have been revolutionalized in the last twenty years by this development.

In law, however, progress is usually quite slow. The reasons for this are legion. Among the most important are the law's tremendous reliance on history and precedent and its somewhat inefficient growth machinery. The former reason is embodied in the doctrine of *Stare decisis*, literally, to stand by decision. This doctrine means that the common law rules as determined by the previous decisions of courts are binding upon present cases except where gross error is found, or where exceptionally good arguments are presented which militate for overruling the earlier decision. One of the axiom's of law, stated by the late Oliver Wendell Homes in *The Common Law* is that "the life of the law has not been logic; it has been experience." With this hindrance to legal development, it becomes apparent that progress, such as it is, will be slow and inefficient.

That the law must eventually develop with social and cultural change is recognized in the truism, "The law must be stable, yet it cannot stand still". Development and change in our legal system is accomplished in the main in three ways. First, in a historical sense, is the legal fiction. Operation of the fiction was by a kind of fairy tale system which invented parties to take action and relations between them in order to bring about a desired effect. The weakness of such a method is apparent, and the fiction has, to a large extent, died of old age.

Legislative enactment is the most widely used means of bringing about development in law. The method is self-explanatory. The Congress, state legislatures, and municipal councils draft, enact, and amend our laws as the social, economic, and political exigencies of the day demand. Every citizen is cognizant of this process, and of its defects, particularly with regard to political machinery, lobbyists, and social pressures.

Equity is the third means by which law develops. It is with this method of growth and its modern application to problems involving the civil engineer that this paper is devoted.

What Is Equity Jurisprudence?

The question posed in the title of this section has been the subject of treatises and papers which num-

ber in the thousands. Obviously a full treatment of such a subject cannot be attempted here. It is therefore the purpose of this section to outline the fundamentals of equity highlighting those points which specifically affect our subject.

Equity jurisprudence began in England sometime after the Norman conquest. The chancellor, at first an ecclesiastical officer, and later a secular officer, was empowered to act for the King to secure justice where it could not be obtained by the usual legal processes. This power of the chancellor to do "equity" (i.e. to reach an equitable disposition in a controversy to which the existing legal system could afford no adequate remedy) gradually expanded into a collateral system of jurisprudence granting extra-legal relief in the interest of justice.

The chancellor was soon unable to cope with the many requests before him and it became necessary to create Courts of Equity to administer equity proceedings.

Equity existed in many American colonies as it was brought by the English. The U.S. Constitution recognized the importance of equity and gave to the Supreme Court jurisdiction in "all cases in law or equity arising under this Constitution and the laws made or to be made (for the United States)." By the latter part of the nineteenth century, equity jurisdiction was a part of the judicial organization of every state.

The modern Codes of Procedures have to abolish many of the distinctions between the system of "law" and the system of "equity". In most states, one system of courts and judges administer both legal and equitable litigation, though many retain separate calendars for hearing cases at law and cases at equity. Passing over many of the details of similarity and distinction between the two systems, we can determine several characteristics which distinguish equity even within the modern merged system, and which make the equity system bear significance to the administrative engineer.

The first major distinction between law and equity is that equity cases are, in general, heard without a jury (there is no right to jury trial) while in most actions at law either party may request a jury as a matter of right. This means that while in law the jury decides questions of fact, and the judge decides questions of law, the judge of equity decides matters of law and fact.

Another Distinction

A second important distinction occurs in the method of enforcing judgments. A successful litigant at law is granted a judgment (i.e.—a final declaration of the rights of the parties including an order that he recover so much money in damages, or recover his chattel or real property) which is presented to the sheriff for enforcement. The sheriff then attempts to collect the money or replevi (retake) the chattel or real property. The law, through the sheriff, acts *(in rem* in the thing) and cannot detain or imprison the defendant though it can attach his property or place a garnishment on his future income. Equity, on the other hand, acts *in personam* (in the person) and directly orders the defendant to do or not to do a certain thing or to return a piece of property or surrender up a document or other instrument that happens to be the object of the suit. If the defendant fails to obey, he is held in contempt of court and may be imprisoned until he performs the desired act. Obviously then, a decree in equity is a far more powerful weapon against a wrongdoer than is a judgment at law.

But it is the third distinction which gives to equity its quality as a mechanism of growth in the jurisprudential system and which lends it well to matter of importance to engineering projects. This distinction is in the type of relief afforded. Traditionally, the common law courts give three kinds of relief—money damage, recovery of a chattel, and recovery of real property—all remedies which the sheriff could reasonably be expected to carry out. Modern statutes have in some measure added to this limited scope: Some jurisdiction now afford judicial declarations of rights and duties under Declaratory Judgment Acts, or hold wrongdoers in contempt for refusing to surrender a chattel. Some expansion has been brought about by the development of the field of quasi-contracts where a contractural obligation can be thrust upon a party unvolitionally by operation of law.

These statutory legal remedies are of minor importance, however, when compared with the scope and effectiveness of equitable remedies.

As previously stated, equity orders the defendant to do or not to do a specific act and failure to execute this order results in the defendant being held in contempt of court. He is then subject to imprisonment until such time as he complies with the order. Thus equity can order among other things, the abatement of a nuisance, the delivery of wrongfully detained goods, the enjoining of a strike, the specific performance of a contractural obligation, and the transfer of securities, notes and other non-negotionables to their rightful owner—all remedies which are extra-legal in that they cannot be administered by a court of law.

By granting these forms of relief as they become necessary to adjust the conflicting interests of adverse litigants in a changing social order, equity introduces reform and growth into the jurisprudential system. Prior to the rise of modern legislative bodies, equity was the major force of legal reform in Anglo-American law. As pointed out by W. W. Cook, writing on Equity in the *Encyclopedia of the Social Sciences,* the law was modified by the development of trusts and uses, of married women's property law, of the enforcement of simple contracts (as a corollary of developing the remedy of specific performance), and by the creation of substantially the whole law of mortgages with its equity of redemption and bills of foreclosure. Equity also introduced defenses into the system—fraud and duress, for example, are equitable defenses which today can almost universally be pleaded in cases at law.

In modern times, much of our legal reform is achieved through the legislative bodies. But where, for one reason or another, legislation is still lacking, equity stands prepared to relieve the harshness and inadequacies of the common

law system. Some of these modern day reforms will soon be seen.

The Engineering Application

It is in the field of construction bidding and contracting that equity has its most important application to the problems of the engineer. Try as we might, mistakes cannot be fully eliminated from engineering and construction estimates, and often they lead to severe consequences when an erroneously low bid is accepted. The mistake in bidding is usually unilateral, that is, a mistake by one party to the contract as opposed to mutual mistake where both parties are in error. The orthodox common law, with its objective test of assent to contract, does not give relief to the unfortunate party for a unilaterial mistake. Thus, if a contractor by mistake makes an offer to do X, though he meant Y, a contrast arose to perform X if the other party reasonably understood the contractor to intend X. This means, in concrete terms, that so long as a bid price was reasonable (not so low as to be obviously in error) the contractor was obligated to perform or pay damages for breach, if the bid was accepted and the contract signed.

An example of such operation of law can be seen in the Massachusetts case of *Franklin A. Snow Co. v. Commonwealth,* 303 Mass. 511, 22 N. E. (2d) 599 (1939). The contractor, Snow, bases his estimates for certain earthmoving and hauling work upon the expectation that quarries adjacent to the construction site would be obtained by the Commonwealth for his use. The Commonwealth's engineer inspected the location with the contractor, pointing out possible sites for the borrow areas. Snow then filed his bid which was accepted—No binding contract had yet arisen since the mere awarding of the contract does not create any legal obligation upon the parties when it is their contemplation that a definite written contract will be prepared and signed—(This is a business usage of the construction trade usually fortified by bid bonds). During the three weeks between award of contract and the execution of the signed writing, Snow was informed that the Commonwealth had not yet acquired the land including the anticipated borrow areas. He received assurance that the officials of the Commonwealth would do everything possible to make the needed acquisition. Upon this assurance, he signed the written contract and furnished the necessary bonds. The land was never acquired, and he had to secure other, more distant, borrow areas resulting in a loss on the job of $136,625.

The Massachusetts court held that Snow Co. was not entitled to damages since in electing to enter the written contract, it had assumed the risk of finding an alternative quarrying site which would enable performance of the contract without loss.

Law May Seem Harsh

The operation of the law here seems harsh, but the argument is submitted that the contractor could have avoided the contract (written) by forfeiting the bid bond thereby reducing the loss to $10,000. Many arguments are available in opposition to the holding of this court and to its suggestion that the loss could have been only $10,000. The case is stated to demonstrate the rigor of the orthodox legalistic approach to the problem. In contrast to this approach is the modern equity view which treats these "contracts of hazard" in a far more desirable fashion. Note that equity has the power to grant relief in forms other than money damages. It can require specific performance (carrying out the terms of the contract instead of merely paying damages for its breach) or it may rescind or cancel the contract (broadly defined as relieving one or both parties of their contractual obligations). Equity's treatment of mistake in construction bids has tended toward recognition of certain types of unilateral mistake. The tendency is to permit non-forfeiture withdrawal of the bid or avoidance of the signed writing providing (1) there is a bona fide hardship mistake, (2) prompt notice is given upon its discovery, (3) to grant relief will not unfairly prejudice the innocent party or the rights acquired by third persons.

Some types of mistakes which have come before the courts have been faulty addition, misreading of blueprints, omission of items, transposition of numbers, improper multiplication, misunderstanding as to location and extent of the work demanded. No doubt this list is growing, and it should be considered as illustrative rather than exhaustive. It is difficult to generalize with regard to the outcome of actions taken upon these various forms of mistake since each state jurisdiction has different rules and precedents which distinguish it from all others. Much attention is given to the consideration of whether the mistake is palpable or inpalpable. It is apparent that the likelihood of relief is much greater in the case of palpable mistakes. But the generalization may be safely submitted that courts of equity, and courts of law which have grown by the adoption of equitable reforms, will grant relief upon unilateral palpable mistake if the forementioned conditions of notice and hardship are met; and relief may be obtained upon unilateral impalpable mistake depending upon the jurisdiction and upon the equities of the particular set of circumstances.

Palpable Mistake

As early as 1900, the Supreme Court of the United States, in *Moffett v. Rochester,* 178 U.S. 373, recognized palpable mistake in an equitable action and refused to follow the letter of a statute declaring all bids to be irrevocable when filed. In holding that due to the mistake there was no real bid capable of being revoked, the court stated (quoting with approval the opinion of the circuit court):

"If the defendants are correct in their contention, there is absolutely no redress for a bidder in public work, no matter how aggravating or palpable his blunder. . . There is no remedy, no escape. If . . . he has agreed to do work worth a million dollars for ten dollars, he must be held to the strict letter of his contract, while equity stands by with folded hands and sees him driven to bankruptcy."

This case has become the leading authority for the recognition of unilateral palpable mistake. Its holding has now been followed in nearly every American jurisdiction. There

(Continued on page 46)

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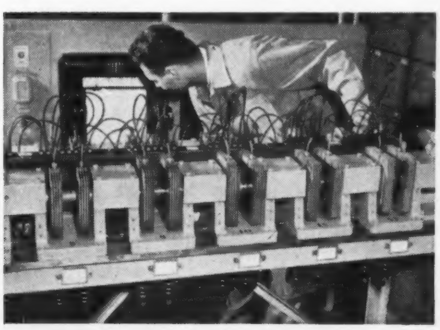

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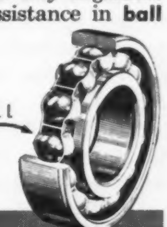

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External Aircraft Noises

by MURRAY KAMRASS, Cornell Aeronautical Laboratory

In recent years man has become increasingly concerned over noise in his environment. The reasons for concern are readily apparent. With the increasing use of high powered machinery in manufacturing and transportation, a proportionate increase in the amount of noise has been realized. This is attributable to the fact that a small fraction of machine power is converted into noise. In the case of a jet engine, for instance, the acoustic energy produced is about one per cent of the kinetic energy in the gas jet. In terms of efficiency this percentage seems small. Nevertheless, the noise radiating from present-day jet engines is intense enough to cause immediate damage to unprotected hearing organs of persons near them.

Even when noise intensity is below the immediate damage level, permanent hearing loss can be caused by prolonged exposure. Considerable data have been collected which show that many industrial workers suffer hearing losses caused by continuous exposure to noise of seemingly bearable intensity.

At a still lower intensity level another important noise region exists. In this region the noise is not likely to cause physical damage, but rather annoyance and interference with some human activities. At the present time there is a great deal of preoccupation, both public and private, with community reactions to such noise. This is particularly so in the case of recently developed high powered aircraft. Complaints, threats and legal actions have arisen against airport operators, aircraft manufacturers and Air Force installations. As a result, study of the problem has been initiated in an attempt to understand the nature of the situation and to determine methods of dealing with it. It is proposed to discuss here the external aircraft noise problem and to show what progress has been made in describing the noise and its effects on human beings.

Noise Source

The noise source itself is one of the three basic elements in the problem. Most sources are directive, that is, the intensity and spectrum vary in different directions from the center of the source. Therefore, it is necessary to measure the distribution of noise energy in various directions. At each point of measurement the noise spectrum should be analyzed in order to specify the noise properly. Octave band analyzers have been found convenient and adequate for most purposes which involve the effect of noise on man. Such instruments usually resolve the noise into eight bands over the frequency range 20-10,000 cycles per second. In the case of a jet engine, for example, the noise generally covers the full spectrum with some fall-off at frequencies below 100 and above 1,200 cycles per second. The maximum intensity at all frequencies occurs near the jet exit at an angle of about 35 to 45 degrees off the engine axis. The minimum intensity occurs directly in front of the engine.

Once the source has been specified quantitatively by the method described, it is possible to calculate (under some conditions as will be discussed later) its propagation through air and something of its effect on human beings.

Path of Sound

The second element of the problem is the path over which the sound must travel. In general, sound is attenuated as it propagates through air. The most significant attenuation factors are described briefly below:

Inverse Square Law: The energy per unit area in a wave radiating spherically in free space attenuates in proportion to the square of the distance from the source. Thus, if the distance from the source is doubled, the intensity is reduced by a factor of four. On the logarithmic scale, doubling the distance results in a decrease of about six decibels.

Wind: The wind has several effects on the propagation of sound. In addition to being a factor in turbulence near the earth, layers of wind can change the path of a sound wave. In the earth's atmosphere a wind velocity gradient is quite common. A position gradient

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He joined C.A.L. in July 1946 as an aeronautical engineer in the Aerodynamic Research Department, after being discharged from the U.S. Army. He transferred to the

Industrial Division in 1952. Previously he was an aerodynamicist with the Stinson Division of Consolidated Vultee Aircraft Corporation.

(increasing with altitude) will tend to refract the sound upward on the upwind side of the source and downward on the downwind side. This factor is responsible for sound "skipping", a phenomenon in which sounds are inaudible short distances from a source but can be heard at long distances.

Temperature: The speed of sound in air is a function of temperature. If the temperature increases with altitude, the path of sound travel is refracted downward. The opposite effect occurs with the more usual negative temperature gradient. The phenomenon is similar to that of a wind gradient. Temperature and wind gradients can interact to reenforce or nullify each other.

Humidity: When sound waves are transmitted through air there is a loss of energy through direct conversion to heat. In dry air this effect is relatively minor, but when even small quantities of water vapor are present the effect may be significant, particularly at higher frequencies.

Turbulence: The atmosphere is normally somewhat turbulent as a result of forces such as convection and wind. Experiments have indicated that the attenuation due to turbulence is higher than that due to humidity in most actual situations. As wind velocity increases, attenuation becomes greater. In addition fluctuations of twenty decibels over fairly short transmission paths have been recorded in gusty weather.

EQUAL LOUDNESS CONTOURS
ATTENUATION OF SOUND IN CALM AIR
40% RELATIVE HUMIDITY
CURVES ARE OCTAVE FREQUENCY BANDS AS INDICATED

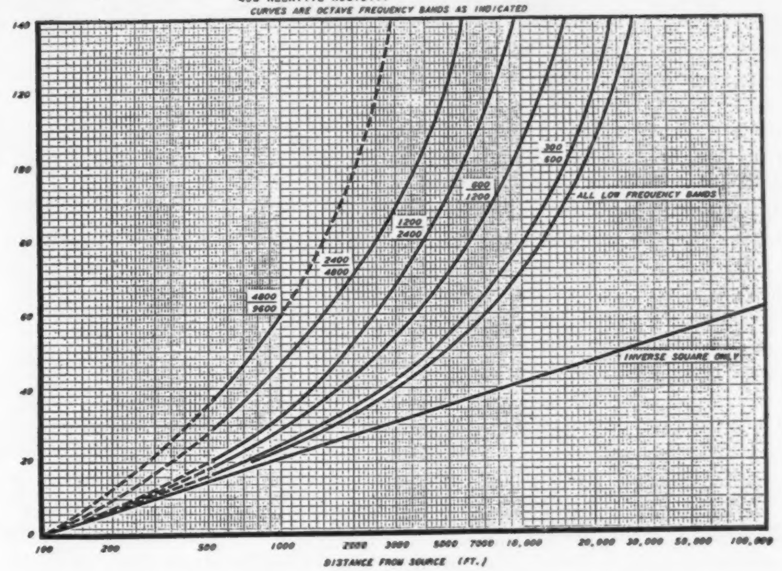


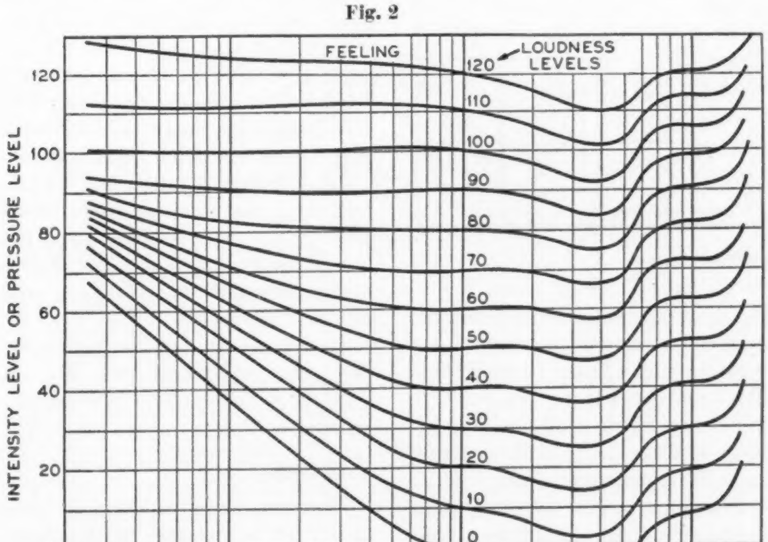
Fig. 1

Ground Attenuation: Sound is markedly attenuated as it passes over grass, trees and other vegetation. For a source at altitude, however, where the sound path has little contact with the earth's surface, ground attenuation is not of much importance.

Barriers: The presence of a barrier between the observer and the source will generally result in further attenuation of the noise. The amount of reduction is dependent on the type and size of the barrier. A solid fence, for instance, would be ineffective in blocking low frequency noise, but may be very effective in stopping a noise of high frequency.

The last four attenutation factors are frequency dependent, the higher frequencies being much more readily attenuated. Often these factors interact in quite complex fashion. For example, attenuation varies with turbulence which in turn is a function of terrain, wind velocity and thermal conditions. Figure 1 shows attenuation data for one particular atmospheric condition, neglecting ground effects, wind and temperature gradients.

Fig. 2



The Third Element

The third and final element of the problem is what we are really concerned about—man himself. The following discussion is divided into three parts. The first two describe two facets of the effect of noise on man. The third describes the reaction of man to the noise maker.

Loudness: One of the most obvious characteristics of noise to human senses is called loudness. Loudness varies with frequency even though the energy level remains the same. Therefore, the over-all level of a noise measured by a sound level meter cannot usually be correlated directly with the sensation felt by a human being. The relationship of loudness to frequency has been investigated by having a number of individuals judge the relative

loudness of various pure tones. From these tests a set of equal loudness contours has been derived. Each contour has been labeled with the same number as the decibel level of the curve at 1,000 cycles per second (Figure 2). These contours define the loudness parameter which is called the phon, and they apply to the special case of pure tones.

An additional problem arises in determining the over-all sensations of complex noises. The latter are composed of many frequency components which may involve a large part of the audible sound spectrum. Under certain circumstances and to a reasonable approximation, it is possible to add the loudness contribution of the eight bands between 20 and 10,000 cycles per second to get an over-all loudness level. Loudness is calculated with the use of a quantity called the sone, an arithmetic unit chosen so that one sone represents the loudness of a 1,000 cycle per second tone of forty decibels sound pressure level. Human judgment of fractional loudness ratios was used

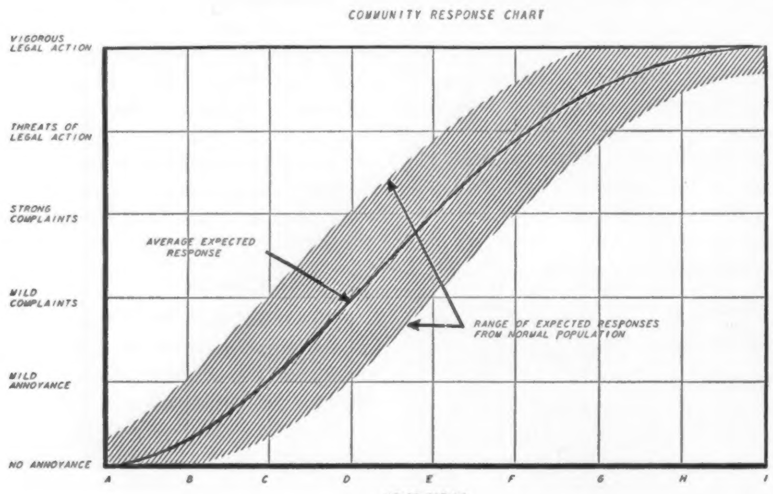


Fig. 4

to derive the sone scale. Since the sone is arithmetic, a sound of ten sones is twice as loud as one of five sones and half as loud as one of twenty sones. The total loudness of a complex sound is thus approximated simply by adding together sones for the eight octave bands. The over-all sone value can then be converted directly to phons.

Speech Interference: Engineering data obtained in designing com-

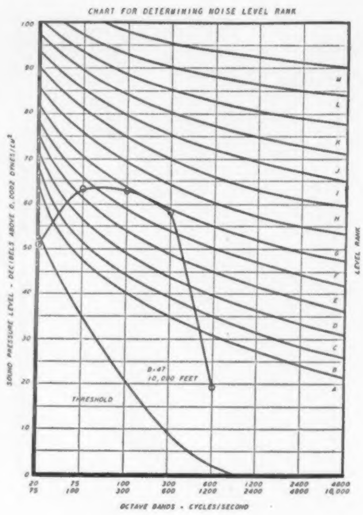


Fig. 3

munications equipment have indicated that the three octave bands 600-1200, 1200-2400, and 2400-4800 cycles per second are the most important for understanding speech. A measure of the interference of a background noise with speech communication is obtained by averaging the sound pressure level of the noise of these three bands. This average is called Speech Interference Level. The criterion is somewhat limited in that it is applicable only for a spectrum which slopes no more than about ten decibels per octave.

It is noted that a subject may become accustomed to ambient noise through experience. But practice or experience are of minimal value in improving the ability to understand speech in the presence of noise near the level where understandability is reduced. For this reason the use of the speech interference criterion as a means of evaluating the significance of noise in such places as classrooms and offices appears to be especially suitable.

Community Reaction: Criteria for determining community reactions to noise are now being developed on a statistical basis. Although no quantitative rating scale has been devised for annoyance itself, it is possible to collect statistics from which the probable response of a community to noise can be evaluated. The response can be scaled through a range which includes no annoyance, mild annoyance, mild complaints, strong complaints, threats of legal action and vigorous legal action. The noises which evoke such response are measured in the octave bands which have been previously described. Further adjustments in response are made to account for factors such as the type of noise (constant or intermittent), the time of day, the type of community, and the previous noise exposure of the community.

Sufficient data (Figures 3 and 4) are now available to forecast with reasonable accuracy a community's reaction to a specified noise. As an example of the use of such data consider the maximum noise created by a B-47 airplane flying 10,000 feet from a suburban community with little previous noise exposure history. These data are plotted in Figure 3. It can be seen that this noise extends into rank F in this figure. Assuming 1 to 10 exposures per hour the level rank can be downgraded to about D. Now, entering Figure 4 at D it can be seen that the probable community reaction is somewhere between mild annoyance and strong complaints with the average at mild complaints.

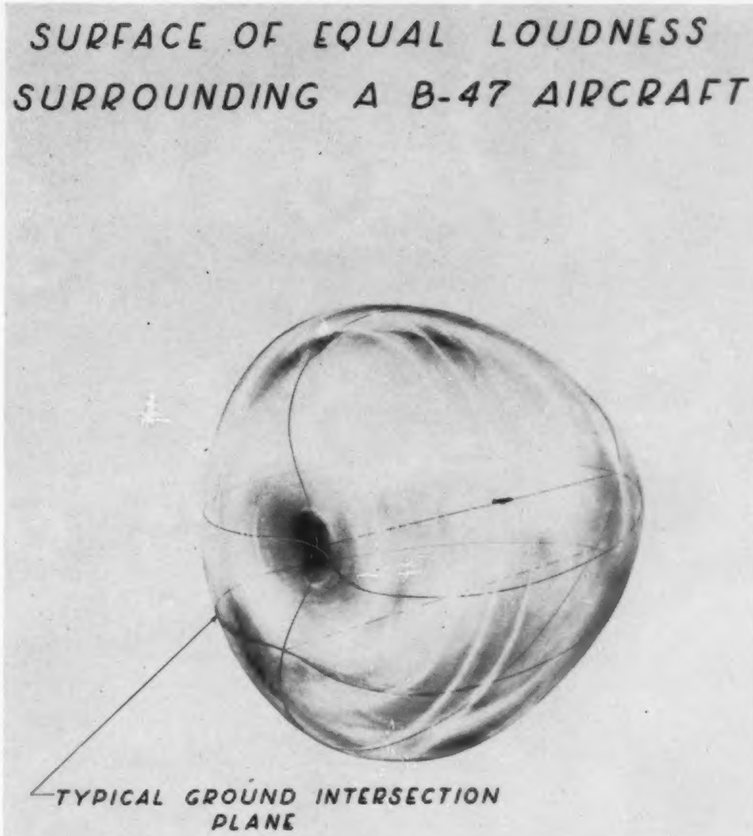
Collection of data is continuing with the expectancy that the accuracy of the method will be improved.

Conclusion

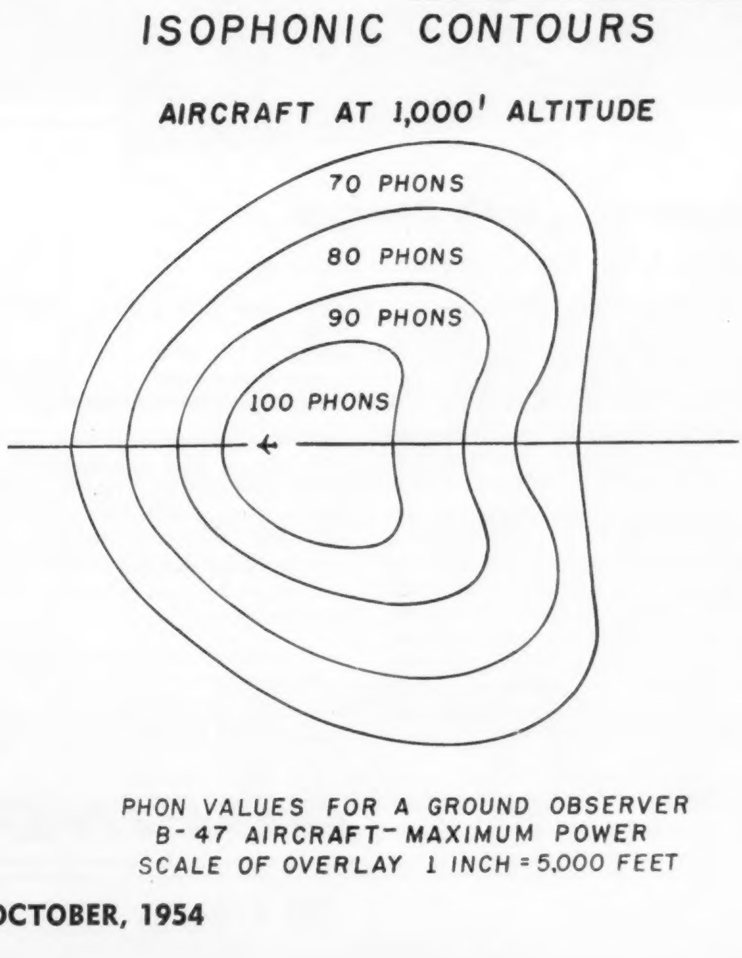
We have tried to show to what extent it is possible to determine the effect of noise on human beings. A number of variables still becloud the picture, however. For example,

the influence of weather on sound propagation is severe and, to a great extent, not defined. Thus, while it may be possible to define attenuation for some standard conditions, the definition is by no means universal. Current research is aimed toward remedying this deficiency.

We shall now try to demonstrate one means of using the principles which were discussed above. Assuming a weather condition for which we have knowledge, it is possible to derive a series of equal loudness contours around a source. Figure 5 is one such contour for a B-47 airplane. All points on the surface of the imaginary pear have equal loudness. It can be seen that the contour intersects the ground in a curve enclosing an area which generally diminishes as the altitude of the airplane increases. Figure 6 contains one set of these ground plane curves. Each curve represents the intersection with the ground of one isophonic



Below: Fig. 6 Right: Fig. 5



(equal loudness) surface when the airplane is flying at the stated latitude. To use such curves a map of the area is needed. Then, transparent overlays of the same scale as that of the map can be imprinted with the ground intersection curves. By sliding an overlay along a projected flight path on the map, the loudness to which ground areas will be subjected can be determined. Similar curves can be made for equal speech interference level or community reaction.

Thus the basic steps have been made for describing noise and some of its effects on man. Such information can be useful in the placement of airports and factories, as well as planning their operation to minimize annoyance and interference. Research is still being carried on with the object of achieving more accurate specification of these factors as well as discovering any new, significant elements. Studies are also being made in the hope of understanding and reducing the noise at the source. But that is a large subject in itself, and outside the scope of this article.

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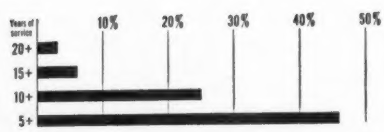

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A MESSAGE TO
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STUDENTS

from J. K. Hodnette, Vice-President and
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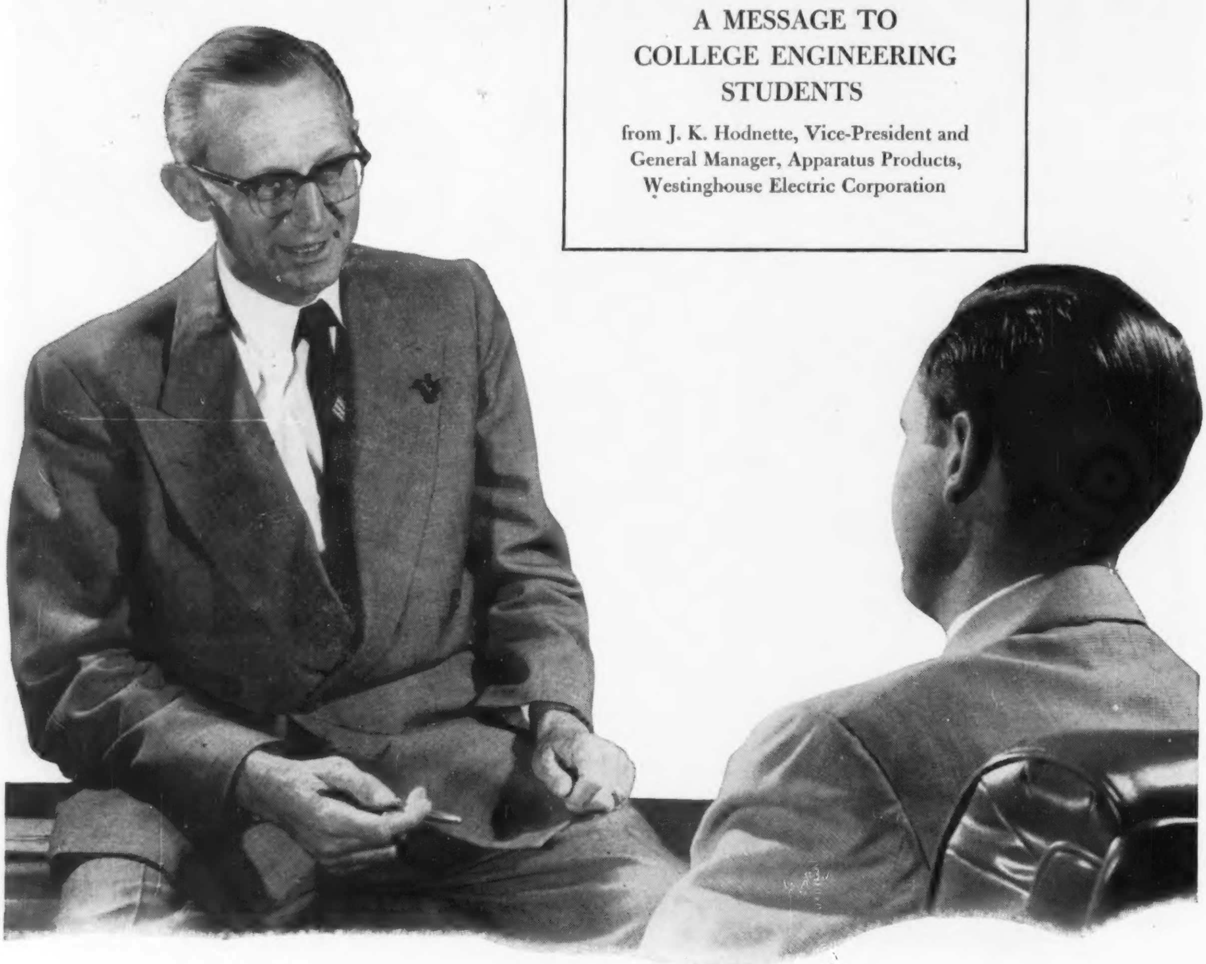
Westinghouse Electric Corporation



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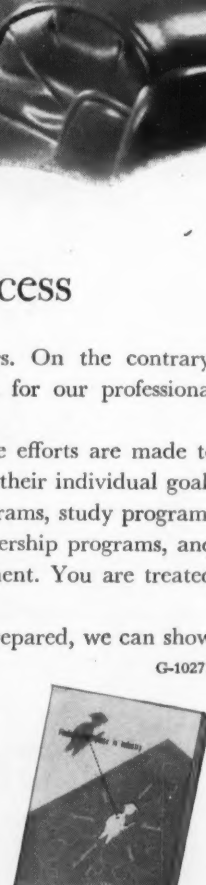

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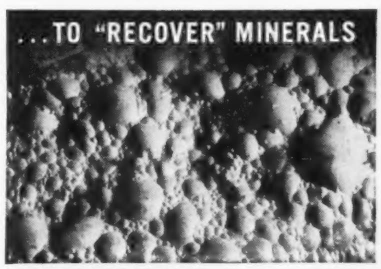

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Faculty Profile

by THOMAS C. REED, M E '56

The impression of the model college professor created by Dr. M. J. Sienko in the minds of most freshman engineers is a notion well backed by reality. An undergraduate at Cornell himself from 1939 to 1943, Dr. Sienko appreciates the value of a saturated lecture; while speaking clearly and with an understanding of the problems involved, he simultaneously dashes through a labyrinth of theory that appalls, then intrigues, the listener. But behind this vigorous lecturer, apparently mechanical and distant because of the size of the classes, lies a very human history capped with good fortune for our University.

After his graduation from Cornell in 1943, Dr. Sienko went to the University of California in Berkeley to work for his doctorate. He labored there for two and a half years, studying the properties of uranium compounds on behalf of the Manhattan Project. He was awarded his degree in February of 1946 but continued to instruct at California for another semester. His next move was to Stanford University at Palo Alto, California, to work for the Office of Naval Research on the question of whether or not metallic sodium in an ammonia solvent acted as a superconductor at a sufficiently low temperature (as had been claimed).

Though it was found that such was not the case, a much less academic question presented itself hand in hand with superconductivity. Married the year before to an undergraduate at California, the doctor was faced with the problem of where he and his bride were to live. She was still a senior at California; he was working at Stanford. A residence halfway between the two turned out to be nothing more than a mirage in the postwar apartment market. As a result the doctor commuted each day from Berkley to Palo Alto, a two hour pilgrimage by bus and train each way. In time it became evident that the popular newsmagazines would not suffice to keep him either awake or sane. The solution was a stiff quantum mechanics text of prodigious size and content—so monstrous as to require all his trips to and from Palo Alto during the following year to master it.

Dr. M. J. Sienko

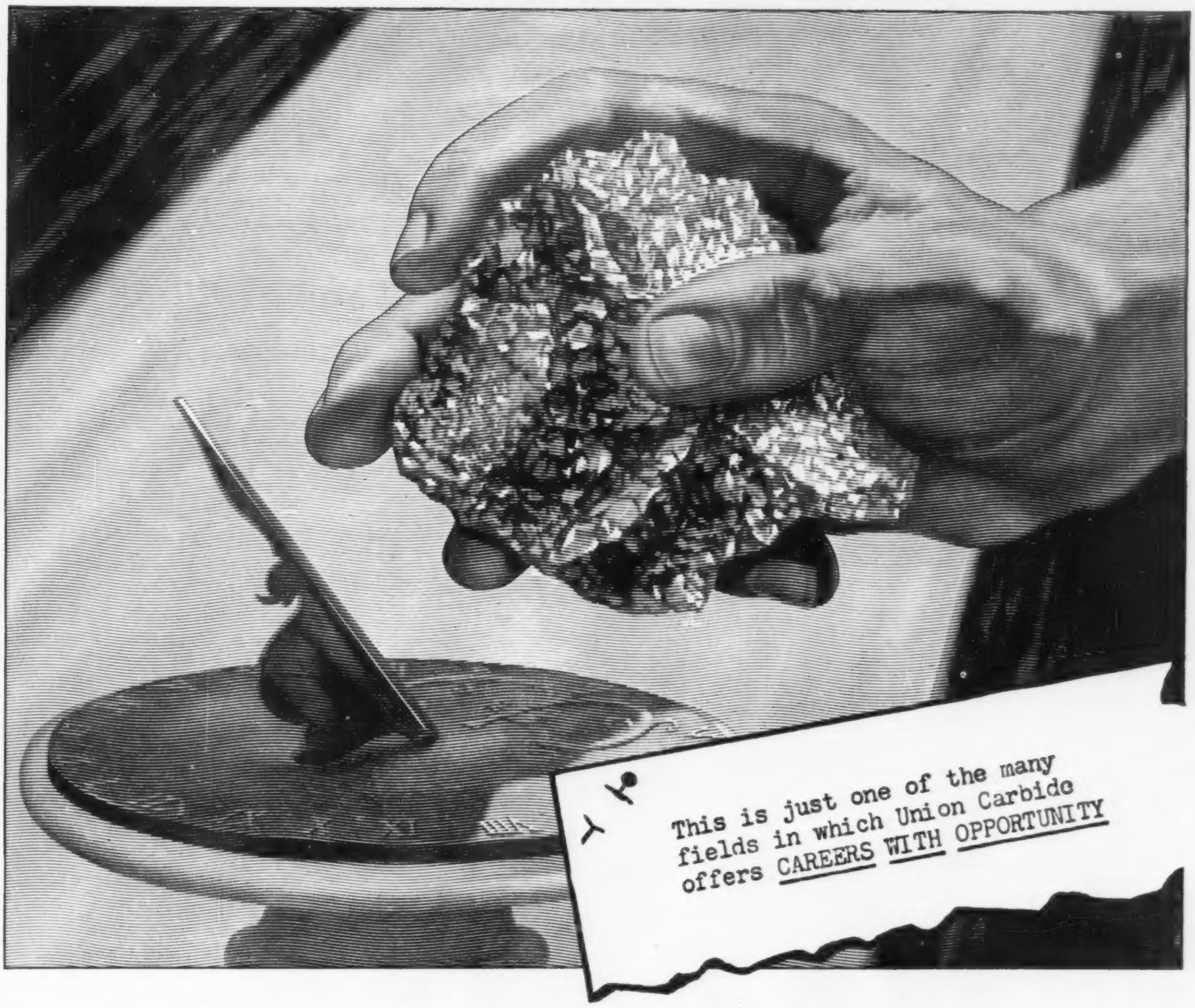
—Matthew Starr

In 1947 Dr. Sienko returned to Cornell. He was appointed assistant professor in 1950, began teaching Chemistry 105 and 106 in the fall of 1951, and last year was appointed associate professor, a welcome addition to one of the country's finest staffs.

His philosophy of teaching and methods of preparation reflect the common sense attitude that has given him his reputation. The general topics of each lecture are decided at the beginning of the year, but the lecture is not actually written until the afternoon following the previous one. At that time an average of five hours is spent preparing for every one hour lecture. Seldom does he allow himself the luxury of reference to any written material either in the form of books or the lecture notes of the year before. He claims that asking the student to remember what he cannot himself recall is unethical.

A shift in emphasis along with expansions of the frontiers of chemistry pose two serious problems to any lecturer, according to Dr. Sienko. First of all, approach to the subject of introductory chemistry is in a constant state of flux. Where the approach used to be historical to the point of starting with alchemy, convention has reversed itself and now dictates an organization based on principles as presently accepted. Likewise, convention pressures for the admittance of new material, such as atomic theory, to the course every year but denounces those who delete any outdated material. The result is a course that never stands still and never stops growing, requiring agile footwork and a sharp pruning knife to keep the giant under control; able use of time and mind to keep it headed in the right direction.

One might wonder as to what holds Dr. Sienko's interest in this field of beginners' chemistry. He might reply something about the inquisitiveness of the freshman mind. Not yet beaten down by prelims and not yet trained to write and parrot back, the freshman mind to him is fearless, asking questions for the sake of curiosity alone. A more universal answer, however, would be mutual interest and respect. Attendance is never taken at a 105 lecture, but Baker 200 is always full. Despite his lack of grey hairs and legendary absent mindedness, he teaches introductory inorganic chemistry with an inspiring thoroughness and ability that leads one to say, "Here is what a lecture should be."



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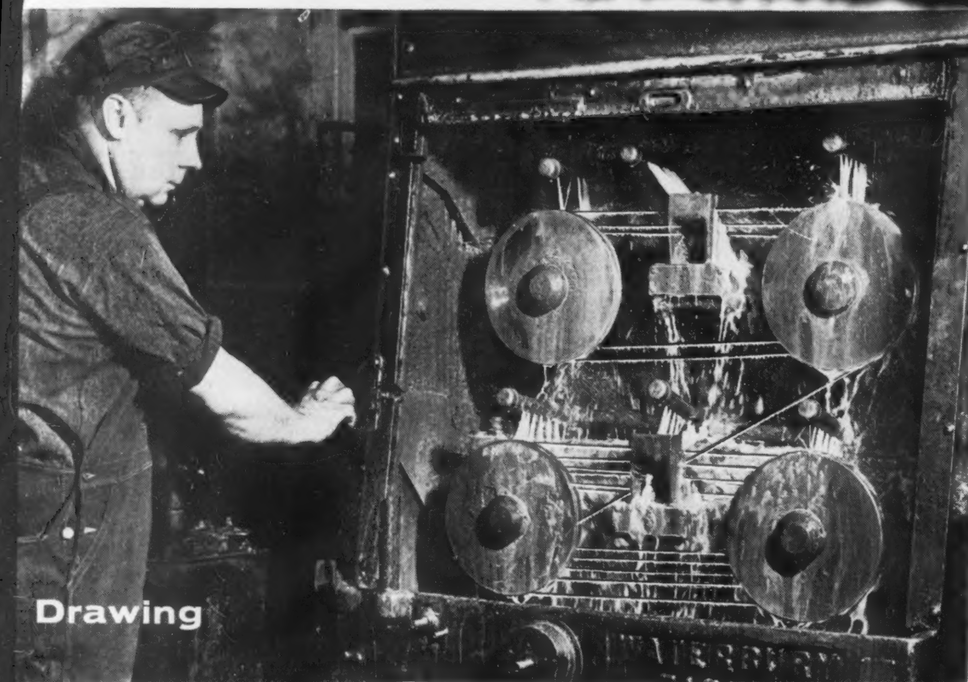
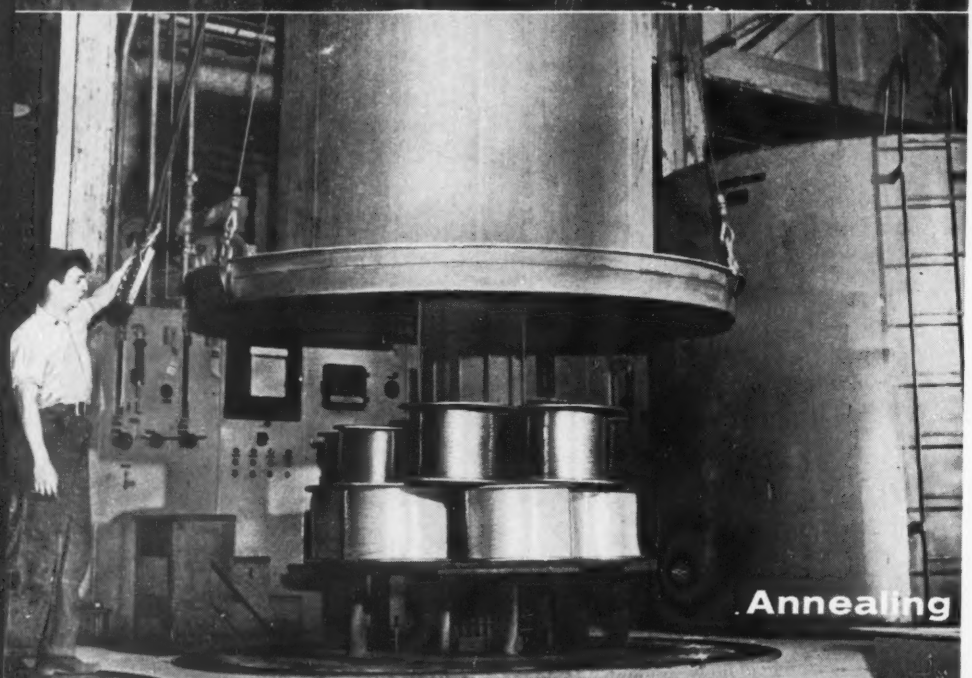
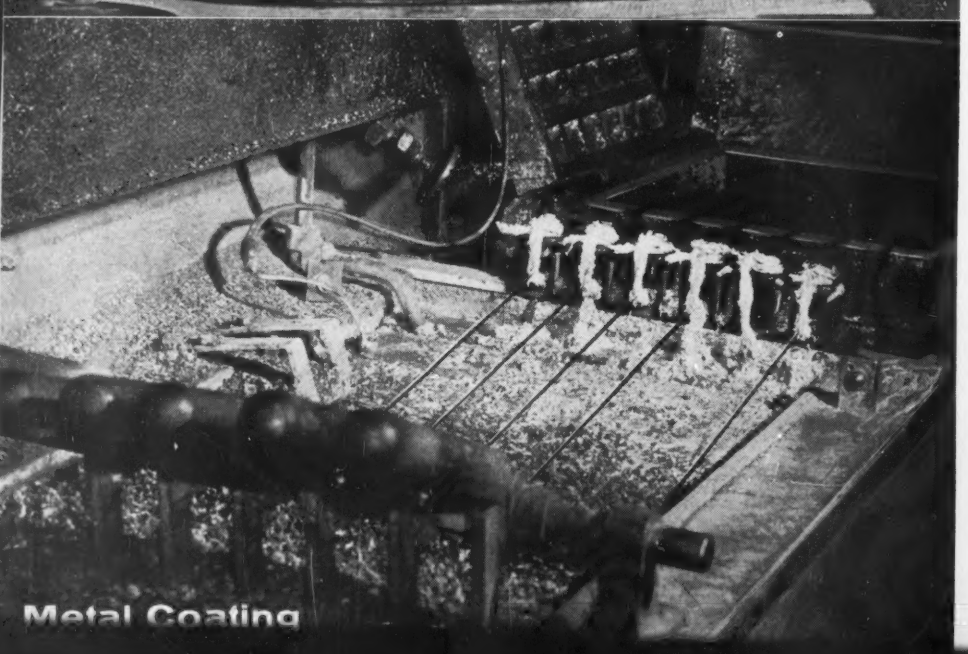

Drawing


Annealing


Metal Coating

The
of

Electrical conductors for wires and cables are generally made from either aluminum or copper. Except as noted below under annealing and metal coating, essentially the same method is used in preparing electrical conductors from these metals.

Preparation of Wires

The metal, after purification at the refinery, is cast into billets about four inches square and about four feet long. For use in electrical conductors, this billet is reduced in cross-sectional area to produce the flexibility required in the finished wire or cable. For example, weatherproof wire for outside power distribution, where little flexibility is required, contains conductors that are solid or made of relatively few wires. For heater cord and welding cable, where excessive flexing in service occurs, the conductors are made up of a large number of small wires. Between these two extremes there is a wide variety of cable constructions requiring numerous sizes of wires.

The reduction in area of the billet is begun on the rolling mill where the billet is reduced to rods, the commercial sizes of which vary from about one-quarter to three-quarters inch in diameter. Rods are reduced to final wire sizes by drawing through a succession of dies of gradually decreasing diameter, the reduction in area per die or draft being about 30 per cent.

Drawing

The drawing of wire increases its hardness and tensile strength and decreases its elongation and electrical conductivity. Since elongation determines the ability of a material to withstand repeated bending or flexing, it follows that the drawing of wire reduces its flexibility. Except where strength is important, as in weatherproof wires supported aerially, practically all electrical conductors should have greater flexibility and electrical conductivity than that provided by hard-drawn wire. Both flexibility and conductivity are improved by annealing hard-drawn wire.

Annealing

Annealing consists of subjecting the wire in coils or on spools to a temperature of about 650°F for about two hours. Large coils or spools may require a longer time and higher temperature. To prevent tarnishing during the annealing of copper wire, it is necessary to anneal in an inert (oxygen free) atmosphere. This precaution is not necessary in annealing aluminum wire. Annealing of hard-drawn wire increases its ultimate elongation about 2000 per cent and electrical conductivity about 3 per cent.

preparation electrical conductors

Bunching

Metal Coating

Unprotected copper in contact with rubber insulation combines with sulphur in the insulation to form copper sulphide. This reduces the conductivity of the copper and makes it brittle and difficult to solder. Furthermore, copper in contact with rubber, accelerates the combination of rubber with oxygen and hence promotes the deterioration of rubber insulation. To prevent this mutually harmful action, copper for use in rubber-insulated wires and cables is protected with either a thin continuous coating of inert metal, such as tin, lead, or lead-tin alloy on the individual wires or a separator consisting of a wrap of threads or tape over the uncoated conductor.

Metal coating consists of passing the individual copper wires successively through (a) dilute hydrochloric acid, (b) molten metal or alloy, (c) a wiper, (d) a cooling bath and finally to a take-up reel. The hydrochloric acid cleans the surface of the copper insuring a perfect union between the copper and the coating metal and a complete coverage of the copper by the coating metal. The wiper removes the excess coating material and produces a smooth surface on the coated wire.

Metal coating or a separator is not required on aluminum conductors for rubber insulated cables since aluminum does not combine readily with sulphur and does not accelerate the deterioration of rubber.

Stranding of Conductors

As pointed out above, the purpose of wire drawing is to so reduce the cross-sectional area of the billet or rod that a conductor of the required flexibility can be produced. In addition to adequate flexibility, the conductor must also have sufficient cross-sectional area to provide the current carrying capacity and voltage drop required for a particular application. In general, the service conditions and current carrying capacity of wires and cables are such that conductors of greater flexibility than is obtained with a single wire (solid conductors) are required. Solid conductors are used generally only on sizes 6 Awg. and smaller conductors and then only for fixed (not portable) installations. Most conductors, are, therefore, made up of more than one wire.

The formation of a conductor by bringing together the required number of wires is known as stranding, and the conductor thus formed is known as a stranded conductor. There are two fundamentally different types of stranding, namely, bunched stranding and concentric stranding. These differ in the manner in which the wires are assembled to form a conductor.

Bunched Stranding

In bunched stranding, the required number of wires are simply twisted together with no attempt being made to control their relative positions within the group. The length of the group requiring a complete turn of any one wire is known as length of lay of the strands. The length of lay varies widely with the number and size of the wires and the flexibility desired in the conductor.

Concentric Stranding

In concentric stranding the individual wires are laid up symmetrically in the form of a geometrically compact group. For example, six wires will lay snugly around one central wire, twelve wires will lay around a group of seven, etc. All of the wires are laid up around the same or a common center, hence the term "concentric stranding". The number of wires in the outer layer increases by six and the total number of wires in the assembly becomes 1, 7, 19, etc. The wires in any one layer are cabled or twisted around the central core with a definite length and direction of lay. The direction of lay of the wires is reversed in alternate layers to equalize the torsional forces resulting from twisting the wires about the central core. The length of lay depends on the size of the individual wires and the number of layers in the conductor.

Rope Stranding

A modification of concentric stranding known as rope stranding is used chiefly in the preparation of large flexible conductors for portable and welding cables. This differs from concentric stranding in that a group of wires, known as ropes, instead of individual wires, are laid up in a geometrically compact form of six around one, etc. These groups of wires may be either concentric or bunched stranded. This type of stranding makes possible building up a conductor with a greater number of wires than can be produced by concentric stranding on a machine with a given number of spools.

Other Strandings

Other types of conductor strandings, such as "sector-shape", "compact-strand" and "segmental" are used for special purposes to reduce conductor diameters and conductor losses.

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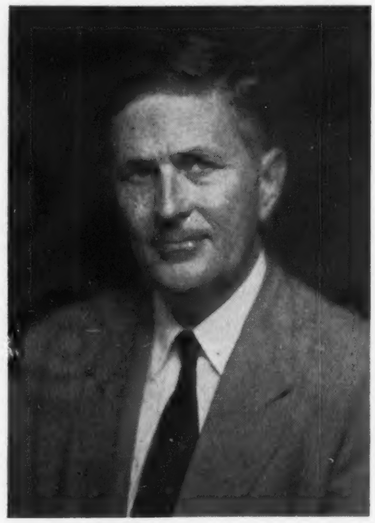

Walter M. Bacon

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The Cornell Society of Engineers congratulates you and welcomes you to our University which meant so much to us as undergraduates and has continued to do so over the years as alumni and we want it to mean as much to you. In the engineering profession the fact that man holds a Cornell degree means a great deal; he is one of the best. This has been true for many years and must continue to be so. The reputation of a university depends on its graduates. Their fitness for the jobs they do, their success in the many types of careers they choose, their place in the communities in which they live, are all factors which contribute to this reputation. When you graduate and take your place in industry and business you will be a part of the body of alumni supporting and increasing Cornell's high standing in the field of engineering education and those who follow will depend on you to make them as graduates of Cornell desirable to industry.

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ALUMNI ENGINEERS

Edwin V. Berg, M.E. (E.E.) '02, 1303 Eighteenth Avenue, Longview, Wash., has been named director of civil defense for Cowlitz County.

Wilber A. (Nick) Carter, M.E. '13, has retired from his regular duties with the Detroit Edison Co. but is being retained as a consultant. He has been active on the civic affairs committee of the Engineering Society of Detroit as well as in the Detroit Yacht Club. He presently resides at 8741 Arcadia Ave. in Detroit.

Wilber A. Carter '13

Gordon (Fletch) F. A. Fletcher, M.E. '24, has for 29 years been with Raymond Concrete Pile Co. and its subsidiaries. He is at the present time project manager and a department head. Fletch is vice-president of Raymond Concrete Pile Co. Ltd., Toronto, and a director of Raymond International Co. Ltd. He serves on the 1924 Class Council and is a member of the Cornell Club of Toronto.

Vincent DeP. Gerbereux, M.E. '24, lives in Upper Montclair, N.J., and is assistant manager of the centrifugal pump division of Worthington Corp., Harrison, N.J. Vince is a past president of the Cornell Club of Essex County and of the N. J. branch of the Cornell Society of Engineers. He serves on the Council of the Engineers' Society. He is a member of the Upper Montclair Country Club.

Gilbert F. (Gil) Rankin, M.E. '24, is vice-president and chief engineer of Manitowoc Shipbuilding Inc., Manitowoc, Wisc. His two sons, **Gil, Jr.,** class of '55, and **James,** class of '58, are both enrolled at Cornell. Gil may be addressed at 419 Park Street, Manitowoc, Wisc.

Thomas J. Redington, B.C.E. '41, is a purchaser for Turner Construction Co., New York City, and lives at 68 Hillside Drive, Apartment 310, Toronto 6, Ontario, Canada. He was married to the former Elizabeth A. McMahon of Scranton, Pa., last June.

Alfred Hagedorn, E.E. '41, B.M.E. '47, B.E.E. '42, and Mrs. Hagedorn **(Beatrice Mead, '42)** announce the birth of a son, George Allan, October 18. Their first son, Alfred Arthur III, was five years old last December 17. Hagerdorn is with the technical staff of Hughes Aircraft Co., Culver City, Cal. Address: 17007 Gault Street, Van Nuys, Cal.

Robert O. Dame, B.E.E. '42, was recently promoted to engineering section head for missile operations in the missile systems engineering department of Sperry Gyroscope Co., Point Mugu, Calif.

Jay Steiner, M.E. '44, has been appointed assistant promotion manager of F. J. Stokes Machine Co. After active duty as an engineering officer in naval aviation during World War II, he began his business career as a salesman with Worthington Corp. and later as a sales engineer with one of Worthington's distributors. He joined the Stokes sales organization in April, 1949.

A first child, Susan Leslie, was born, November 4, to **Robert E. Claar, B.M.E. '47, B. S.'47,** and Mrs. Claar **(Janet Grafton '47)** They live at 300 Turnpike Street, Canton, Mass. Claar is a design engineer with James Russell Engineering Works, Dorchester, Mass.

Hugh F. Dodge '53

Robert H. Heath, B.S. in A.E. '47, 70 Mountain Way, Morris Plains, N.J., has a son, Robert Jr., born February 14. Heath is the son of **Raymond P. Heath '11** and is an industrial engineer with Hyatt Bridge Division, General Motors Corp., Harrison, N.J.

Jerry Grey, B.M.E. '47, B.S. 48, M.S. 49, is a research associate at Princeton, where he directs a research program in rocket combustion and teaches aerodynamics and jet propulsion in the department of aeronautical engineering.

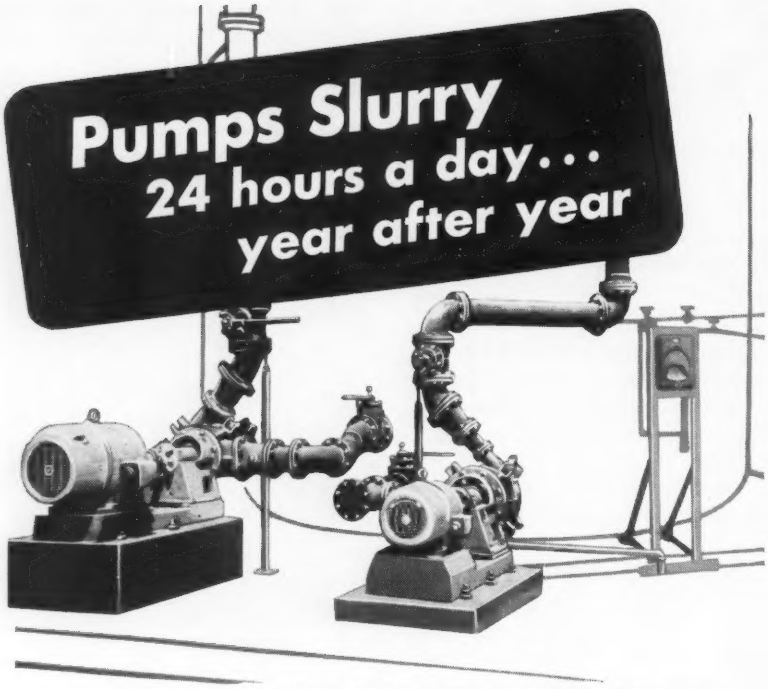
Daniel W. Brown, Chem.E. '48, has married Miss Arvikka F. Jacobson of River Falls, Wis. Brown is employed at the U.S. Bureau of Standards, and lives at 2607 Nicholson Street, West Hyattsville, Md.

Kenneth O. Jensen, B.E.E. '48, is an assistant product engineer with Sperry Gyroscope Co., Great Neck, He has a son, Alan Reed, who was one year old this June. Jensen's address is 260-38 Seventy-fourth Avenue, Glen Oaks, Floral Park.

Hugh F. Dodge, Grad '53, now lives in Santa Cruz, Calif. and is employed by the Pacific region, U.S. Geological Survey.

Necrology

Philip Bevier Hasbrouck, M.E. '96, 8201 Sierra Avenue, Fontana,



● MORRIS TYPE R SLURRY PUMP at the left is on continuous 24-hr. duty delivering 1000 GPM of a 170° lime slurry at 100′ head. Fifty-HP motor operates at 1180 RPM. Intermittent-duty pump at right delivers 200 GPM at 50′ head with 7½-HP motor turning at 880 RPM.

In slurry-handling operations, "long-term service" is a meaningless claim unless the pump will work day-in and day-out with a minimum of maintenance time, trouble and expense

Morris Type R Slurry Pumps—with an established reputation for longer life—also incorporate in their design exclusive features which result in easier installation . . . fewer interruptions to service...less overhaul...fewer replacements.

To provide uninterrupted service . . .

The gland is under suction pressure only. This reduces leakage and dilution . . . keeps harsh abrasives out of the stuffing box . . . practically eliminates packing troubles.

There are no internal studs or bolts. Caustic and corrosive solutions cannot seep past threads and cause maintenance headaches.

To make installation and dismantling easy . . .

Shell is interchangeable for right or left hand rotation. Suction and discharge nozzles can be rotated around the axis of the pump to a total of 72 different locations.

Impeller removed without disturbing the piping. You simply loosen 4 *outside* clamping bolts and pull off the end cover. This feature alone saves considerable time and labor.

● *Free Service.* Morris Engineers will be glad to recommend the pump best suited to your needs for size, capacity, etc. Send necessary data today . . . include request for Bulletin 181.

MORRIS MACHINE WORKS
Baldwinsville, N. Y.
Sales Offices in Principal Cities

MORRIS *Centrifugal Pumps*

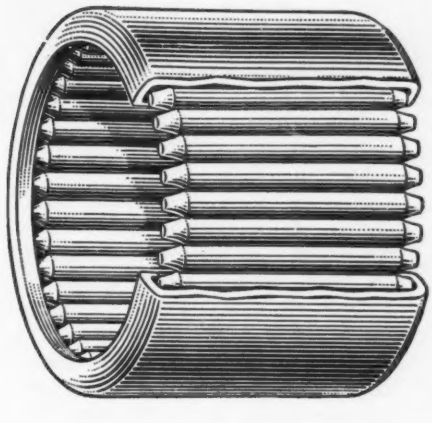
Calif., November 26, 1953. He had been manager of Fontana Union Water Co. for twenty-six years before retiring in 1951. He was director of Santa Ana River Water Association and Santa Ana River Weather Corp.

Meier George Hilpert, C.E. '01, February 11, 1954. He was for forty-two years assistant to the chief engineer of the bridge department, Bethlehem Steel Co., Bethlehem, Pa., where he lived at 37 West Church Street. As consulting engineer for Frederick R. Harris, Inc., New York City, he supervised construction of aircraft runways for the US Navy.

Lee Arden Thomas, B.Arch. '10, Vancouver, Wash., November 30, 1953. He practiced architecture in the Pacific Northwest for more than forty years. During and after World War II, he planned service buildings for the Army in Alaska and worked on the McNary Dam and Willamette Basin Project in Oregon. Phi Kappa Psi.

William Winton Goodrich Rossiter, M.E. '11, February 13, 1954, at his home, 4 Midland Gardens, Bronxville. A member of the New York Stock Exchange since 1926 and a former member of its board of governors, Rossiter was a partner in the brokerage firm of James Oliphant & Co., New York City, and a director of Broadway Savings Bank. Last year, he raised from members of the Stock Exchange a gift of $220 for the Cornell Club of Seoul, Korea. Sons, William G. Rossiter, Jr. '37, Professor Clinton L. Rossiter III '39, Government; brother, C. Lawrence Rossiter '17. Sigma Phi.

Abbott Philip (Abraham) Herman, C.E. '19, '20, professor of sociology at University of Redlands, Calif., January 18, 1954. From 1925-28, he was pastor of the McKenley Presbyterian Church in Champaign, Ill., and from 1928-30 was director of the Westminster Foundation at University of Chicago. He was the author of many articles on sociology and of a book, **An Approach to Social Problems,** published in 1949 by Ginn & Co. He lived in Redlands at 1301 East Colton Avenue, Eleusis.



This is a Torrington Needle Bearing

Designed for Today's Needs and Tomorrow's Trends—
Needle Bearings Offer A Unique Combination of Advantages

The Torrington Needle Bearing has two component parts—the full complement of relatively small diameter, thru-hardened, precision-ground rollers and a case hardened retaining shell by which they are held.

The bearing is a complete unit in itself, and is easily pressed into position in a bore machined to proper dimensions. The advantages of this unit construction in simplifying installation and speeding assembly are readily apparent.

High Radial Capacity

Of special importance is the high capacity of the Torrington Needle Bearing. This efficient anti-friction unit can carry a greater radial load than any other bearing of comparable outside diameter due to the large number of rollers. The small cross section of the bearing allows a large shaft which permits a rigid design with minimum shaft deflection.

Efficient Lubrication

The method of lubrication is another feature of the Torrington Needle Bearing. The retaining shell with its turned-in lips provides a natural reservoir for the lubricant. Thus the needle rollers turn in an oil or grease bath and continually bring up a fresh film of lubricant—insuring rotation of all moving members on a fluid film.

Low Cost

The size of the Torrington Needle Bearing, coupled with the simplicity of its construction, makes it a comparatively inexpensive anti-friction unit. Its compact size encourages simplified design which requires less material in surrounding components. This also contributes to further cost reductions.

The shaft serves as the inner race in the majority of Needle Bearing applications and therefore should be hardened and ground to proper dimensions. However, where it is desirable to use an unhardened shaft, an inner race can be supplied.

For Modern Design

Where the efficiency of anti-friction operation is desired, and where space, weight and cost are vitally important considerations, Needle Bearings provide a logical answer. That's why you will find them used in an ever-growing list of applications.

This is one of a series of advertisements designed to give you the latest engineering information on Needle Bearings. Should you have occasion to work with bearing design or wish more information, write our engineering department.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON *NEEDLE* BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS

Facts for

As a service to newly-matriculated engineering students, the CORNELL ENGINEER presents here some basic and useful information about the curriculum, scholarship assistance, and employment opportunities that you will encounter.

First term classes for all freshman engineers follow the pattern of providing a basic background in mathematics, physics, chemistry, and English. Although specific schools may require a machine tool process course or additional work in chemistry or mechanical drawing, every freshman engineer encounters these four fundamental subjects.

Mathematics 161, a three credit hour course meeting three times a week, is designed to introduce the basic concepts of analytical geometry, graphing of functions, and calculus. The meaning of limits and the derivatives of functions is explained. Students learn the methods of taking derivatives and how to apply them in analysing curves in terms of their maxima, minima, and points of inflection. Practical problems emphasize the use of the mathematical concepts in determinig the most economical dimensions of a conainer made of a material of known cost, or problems involving velocity and acceleration. The theory of integration is presented as well as its geometrical applications in determining volume and area. Generally problems are assigned for homework dealing with each class lesson, giving the student an opportunity to develop his own ability in manipulating the mathematical tools presented in the course. These tools are basic concepts that underlie all later use of mathematics in engineering.

Inorganic Chemistry

A majority of freshman engineers, except students in chemical and metalurgical engineering, take chemistry 105, a basic course in inorganic chemistry. The course includes two lectures and one recitation-lab period each week. Here the emphasis is on the lectures, and exams are based for the most part upon lecture material with a few questions on specific laboratory experiments. The course itself covers the basic laws of chemistry, a background of the history of man's understanding of the atom as related to chemistry, and the principles of atomic structure from the chemist's point of view.

The concepts of chemical bonding, formula writing, and equations are developed in the lectures. In addition, oxidation and reduction is outlined. The course covers the states of matter, explaining the behavior and relationship of gases, liquids, and solids and the nature of solutions is presented in preparation for the study of chemical equilibria. The rates of chemical reactions and electrolysis are also included in Chemistry 105. A number of problems sets are given as homework to further illustrate the meaning of quantitative ideas presented in the lectures. Laboratory experiments are related to lecture material and include such problems as determing the molar volume of a gas, the equivalent weight of a metal, or the relationship between freezing point depression and molecular weight. Weekly quizzes are given before lab sessions to check the student's understanding of each week's lecture material. The lectures are supplemented by demonstrations clarifying the main points and important principles.

First Term Physics

All engineers are introduced to the fundamentals of physics in Physics 115, a study of mechanics. The course is set up on the basis of two recitations, one lecture, and one lab each week. The recitations deal mainly with the homework problems assigned for each meeting and enable the student to ask questions about course material. Lectures clarify by a variety of demonstrations the concepts presented in the text and manipulated in homework problems. The course includes an explanation of the meaning of forces and their application in Newton's first law. Coefficients of friction and moments are presented, along with equilibrium and center of gravity concepts. Rectilinear motion, Newton's second law, the motion of projectiles, work and energy, impulse and momentum, circular motion, rotation, elasticity, harmonic motion, and an introduction to hydrostatics and hydrodynamics are surveyed in the course. Lectures not only utilize specially designed illustrative apparatus but provide entertaining as well as educational demonstrations such as the effects of a gyroscope mounted within a suitcase, closed circuit television for detail observation, and principles explained while the lecturer is standing on moving carts and rotating turntables. The physics laboratory is designed to improve the student's understanding of physics by enabling him to develop skill in handling a variety of apparatus and in procedures for the accurate determination of experimental data.

Rounding out the series of basic engineering subjects is English 111, a required course for all Cornell freshmen. The course is designed to develop the student's ability to recognize the purpose and the methods of various types of writing. Practice is given in picking out flaws in writing mechanics, and appreciation of good composition is encouraged by reading selections by accomplished authors. About six themes are required utilizing the broad ideas presented on the types of prose-writing. In advanced sections a term paper is written. Classes meet three times each week to evaluate and discuss writing techniques. Emphasis is placed on diction and organization of ideas. Benefit from English 111 is largely up to the individual student and is dependent upon his desire and personal effort to use the principles of clear, logical writing. English 111 gives engineers an opportunity to develop the indispensible ability of communicating written ideas effectively.

Scholarship Aid

Financial aid in the form of scholarships is administered by the

Freshman

College of Engineering. Although they are both designated as scholarships, there are two main types of assistance available: actual scholarships awarded on the basis of scholastic ability and professional promise, and grants-in-aid recognizing financial need regardless of scholastic ability.

Included in the first category are scholarships available to incoming freshmen, including the Lockheed, Sloan, and McMullen awards. These scholarships are given for the duration of the college course if the recipient maintains a high grade average. Also available only to incoming freshmen are the Burrell scholarships, which are essentially grants-in-aid. These grants amount to four hundred dollars and have been given to twenty-six students in this year's freshman class.

Although no scholarship assistance is available for freshmen after they have registered, students may apply for scholarships starting in the sophomore year. The major part of this aid is in the form of McMullen Undergraduate Scholarships awarded on the basis of financial need. Some industrial scholarships are available for upperclassmen in their third, fourth or fifth year, and are usually awarded on recommendation from faculties of the individual engineering schools.

Loans Are Also Possible

Student loans, made from the university's loan funds, provide another source of financial aid. Application for loans can be made through the Office of the Dean of Men. Student loans bear no interest until the time of graduation, enabling the borrower to pay back the loan with interest accumulated only during a period in which he is employed.

The College of Engineering draws upon the John McMullen Fund as its major source of scholarship money. The Fund was donated by John McMullen, former head of the Atlantic, Gulf, and Pacific Company, and was established by the Trustees of the University in 1924. McMullen requested that the income from his estate be used to create " . . . Free scholarships for the education of young men as engineers . . ." Today the McMullen Fund amounts to almost four million dollars, and the annual income from the fund, totaling between $150,000 and $160,000, is used for scholarships. McMullen Regional Scholarships are awarded to over fifty entering students in all branches of engineering. McMullen Undergraduate Scholarships are awarded to upperclassmen and ten or more McMullen Graduate Scholarships are given annually to students enrolled for advanced engineering degrees.

The procedure for a freshman engineer in applying for a scholarship is as follows: first, make application through the chairman of the scholarship committee in the school in which you are enrolled. Second, remember that applications are accepted at any time, but that school scholarship committee chairmen usually post notices late in the fall for those applying for aid in the second term, and late in the spring for the following fall term. Third, keep in mind that committees require a budget of your expenses and resources as a part of the application. Need is determined in competition with other students requesting aid.Freshmen are reminded that the earliest time they can make application is in the spring for the next fall term, because scholarship aid is not available after the student is registered during the freshman year.

All freshmen interested in scholarship assistance should obtain a copy of the official University publication, "Scholarships and Grants-in-Aid." This booklet contains instructions for proper application procedure. Freshmen are urged to remember that many students make a mistake when, finding themselves in serious financial need, they fail to apply for scholarships because they believe aid is given only to top students. There are other grants available so that any engineering student, as long as he is not on probation, may be entitled to some form of scholarship assistance.

The extent of the scholarship program of the College of Engineering is reflected in the fact that for 1952-1953 the total amount of scholarships awarded by the College was valued at $229,500. This figure includes awards made to about 375 undergraduates, whose scholarships alone amounted to $182,500. This comprehensive program of financial assistance allows about one in every four engineering students to receive some form of scholarship aid from the funds administered by the College of Engineering.

Part Time Employment Opportunities

The best jobs available to meet the needs and programs of incoming freshman are, according to the office of the Dean of Men, those paying for board. Students may earn their board by waiting on tables or doing similar work at the University residential Halls, Willard Straight Cafeteria, Home Economics Cafeteria, or the Dairy Bar. Jobs are available in fraternities and sororities Freshman engineers interested in part time work are urged to seek jobs of this nature, enabling them to earn their meals without interfering with their studies.

A few job opportunities may be available in which both room and board or room-rent alone can be earned. In these cases, a student is usually required to work one hour a day for room rent and one hour for each meal.

Part-time cash work opportunities include gardening, carpentry, and odd jobs in homes and stores. Students may work in one of several libraries to earn extra money. There are a few positions that may be available for freshmen that require washing of laboratory glassware. Clerical jobs, including typing and stuffing envelopes, are often open. In the Fall and Spring, a student with free time in the afternoon can

(Continued on page 38)

College News

Long-range development of Cornell University is taking a giant step forward this year through a $22,000,000 building program, largest in the institution's history.

Embracing ten separate projects, the program extends from one end of the campus to the other and reaches also to Cornell's chief off-campus centers, Buffalo, Geneva and New York City. Both the privately-endowded divisions and the State-supported contract units are involved.

Biggest of the Ithaca projects will provide a modern laboratory-teaching center for the Veterinary College. Financed by legislative appropriation, the $5,500,000 construction will give the college 19 new buildings grouped on a spacious new site at the east edge of the campus. When the units are occupied, probably in 1956, the present veterinary buildings at the center of the campus will be remodelled for the School of Industrial and Labor Relations, now in temporary quarters.

At the opposite end of the campus, six dormitories to accommodate 1,350 men have risen adjacent to the World War I Memorial. They were erected from University funds at a cost of $4,200,000.

Other major projects include a $2,000,000 men's sports building, Teagle Hall, given by Mr. and Mrs. Walter C. Teagle of East Port Chester, Conn., and already in partial use; a $1,600,000 electrical engineering center, Phillips Hall, a gift of the Phillips Foundation in honor of Ellis L. Phillips of Plandome, L.I., started last winter as the third unit of a new Engineering Quadrangle; and a $2,500,000 agricultural engineering laboratory-classroom building, financed by State appropriation, for the College of Agriculture.

Also part of the program in Ithaca are a men's squash court building, for which Leroy R. Grumman of Plandome gave $110,000, and a $350,000 alteration of Willard Straight Hall, the student union building.

At the Cornell Aeronautical Laboratory in Buffalo, work will begin shortly on a $1,750,000 addition which will virtually double the laboratory-owned space. At Cornell Medical College in New York, a $2,500,000 student residence, named for the late Franklin W. Olin and a gift of the Olin Foundation, is approaching completion.

In Geneva, a $1,800,000 legislative appropriation will provide a new food science laboratory for the Cornell-operated State Agricultural Experiment Station.

Research At Cornell

Cornell's sponsored reasearch program for 1953-54 added up to $20,100,000, passing the 20-million dollar mark for the first time.

More than half of the total, $10,600,000, was accounted for by research at the Cornell Aeronautical Laboratory in Buffalo. Work in the University's state-supported units amounted to $5,400,000, in the endowed colleges at Ithaca to $2,500,000, and in the Medical College, in New York City, to $1,700,000.

More than 1,000 separate projects are under way throughout the University ranging from studies of the ionosphere and convection heat transfer to others with hybrid berries and avian eggs.

"Again this year I can report that our campus at Ithaca is appropriately free from any project classified under military security regulations," declared Dr. T. P. Wright, Cornell University Vice-President for research. "The same holds for the Medical College in New York."

He explained in his annual report to the Cornell Board of Trustees that classified research is concentrated at the Laboratory in Buffalo, and that the bulk of the activity there falls into that category, although a recently activated industrial division is doing more and more non-secret work.

Ford Fellowship Awarded

The first winner of the Hannibal C. Ford Fellowship for advanced study in enginering at Cornell University is Neal Pike, a '54 graduate of Rutgers University.

The Hannibal C. Ford Fellowship was established last year to honor Mr. Ford of the class of 1903 at Cornell. The fellowship provides $4000 for a year's study at graduate level at the Graduate School of Cornell. It allows study in the Departments of Electrical Engineering, Mechanical Engineering, Engineering Physics, as well as Mechanics and Materials. After applications close in the spring, the engineering faculty send a recommended list to the Ford Instrument Co., sponsors of the fellowshp. The Company narrows the field to five candidates, and from these the winner is chosen by a Cornell interviewing board.

Mr. Pike will enter Cornell Graduate School this fall to start work for his M.S. degree in Electrical Engineering. He plans to major in microwave techniques and to devote his career to research in that field.

School Societies

TAU BETA PI

Tau Beta Pi, founded at Lehigh University, is a national scholastic honorary organization for men in all branches of engineering. Cornell's chapter is an active group in the College of Engineering. In the fall, Tau Beta Pi holds slide rule classes in the evening for the benefit of freshmen. This society also offers free tutoring service; any Engineering freshman may apply for this service at the dean's office of his school.

This year's officers are:

President .... Robert Kahle
Vice-President .... Leonard Mende
Recording Secretary
Alan Eschenroeder
Corresponding Secretary
John Schmutz
Treasurer .... William Macomber
Cataloguer .... Fred Jensen
Social Chairman .... John Browning

(Continued on page 38)

"Allis-Chalmers Graduate Training Course Gave me a head start"

says GERALD SMART
Marquette University, BS—1948
and now Supervisor of Plant Engineering,
Allis-Chalmers, Norwood, Ohio, Works

"MOST MEN graduating from college don't have a clear idea of what they want to do. These individuals are helped by Allis-Chalmers Graduate Training Course to find the right job whether it be in design, sales, engineering, research or manufacturing.

"My case is a little different, however. I started the course with all my interest centered on tool design and 'in-plant' service. The reason is that I started getting vocational guidance from some very helpful Allis-Chalmers men back in 1940."

Served Apprenticeship

"At their suggestion I had gone to school part time while working full time. This not only gave me the chance to serve an apprenticeship as a tool and die maker, and earn money, but I learned what I wanted to do after graduation.

"Then came the war and service in the Navy. After the war I finished school. By the time I started on the course in 1948, I knew what I liked and seemed best fitted to do. As a result, my entire time as a GTC student was spent in the shops.

"The 18 months spent in the foundry, erection floor and machine shop have all proved valuable background for my present job.

"As supervisor of plant engineering at the Norwood Works, I am concerned with such problems as: Plant layout, material handling equipment and methods, new construction, new production methods to be used in building motors, centrifugal pumps, and *Texrope* drives. It's an extremely interesting job.

"From my experience, I'd say, whether you're a freshman or a senior it will pay you to talk to an Allis-Chalmers representative now. You can't start planning your future too soon. And you can't plan starting at a better place, because Allis-Chalmers builds so many different products that you'll find any type of engineering activity you could possibly want right here."

Facts You Should Know About the ALLIS-CHALMERS Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

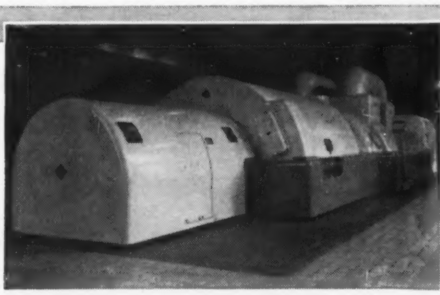
3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance of experienced, helpful superiors in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisc.



Steam turbines, condensers, transformers, switchgear, regulators are built for electric power industry.

Motors, control, *Texrope* V-belt drives—all by Allis-Chalmers are used throughout industry.

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ALLIS-CHALMERS

Texrope is an Allis-Chalmers trademark.

College News

(Continued from page 36)

KAPPA TAU CHI

Kappa Tau Chi is the scholastic honorary society for men interested in the industrial field of mechanical engineering. The society has been active at Cornell since 1933. It promotes activities which will benefit the Administrative Engineering program at Cornell as well as improve student-faculty relations in the Sibley School. Kappa Tau Chi originated the project which led to the Engineers' lounge in Sibley.

Officers for this year are:

President ....S. Sherwood Strong
Vice-President ....Hall Skeen
Secretary ....Dick Lewis

PI TAU SIGMA

Pi Tau Sigma is a national scholastic honorary society for men in mechanical engineering. This group actively serves the school. As a major project it conducts review clases in preparation for the Professional Engineers' License exams.

This term's officers are:

President, Marvin H. Anderson, Jr.
Vice-President, S. Sherwood Strong
Rec. Secretary
George H. Dalsheimer
Cor. Secretary .....Thomas H. Arnott
Treasurer ....Robert V. Kahle
Social Chairman
Donald C. Franklin, Jr.

CHI EPSILON

Chi Epsilon is a National Honorary Civil Engineering Fraternity. Members in the fourth and fifth-year classes become eligible through high scholarship, but must also show outstanding character, practicality and sociability to be elected to membership.

Chi Epsilon offers its members a close association with the Civil Engineering faculty. At present Chi Epsilon is working on a constructive re-evaluation of the curriculum in cooperation with the faculty.

Every year the fraternity conducts a course survey designed for the benefit of the faculty in improving and revising their courses. This spring the annual Engineer's Day display in the C.E. School was under the direction of Chi Epsilon and received the award for the best school display. In April of this year the Cornell Chapter of Chi Epsilon was host to the National Conclave. At this time one of the Cornell chapter's members had the honor of being the 10,000th initiate of Chi Epsilon.

Officers for the Fall Term, 1954:

President .....Martin L. Rosenzweig
Vice-President .... Jack E. Felt
Secretary-Treasurer
Richard B. Walker
Associate Editor of the
"Transit" ....Alan F. Cohen

Students Receive Grant

Four Cornell students have been awarded Clevite Senior Scholarships of $250 each for their final year at the university, 1954-55. The scholarships are from a $1,000 grant given by the Clevite Corporation of Cleveland, Ohio, for students showing excellent performance and promise in engineering, chemistry, physics or business administration.

The winners are Claude C. Cornwall, Jr., College of Arts and Sciences; Alan M. Jacobs, Department of Engineering Physics; Leonard Mende, School of Electrical Enginering; and Martha Snitker, College of Arts and Sciences.

Jacobs and Mende are both members of the Engineering Council.

Hints for Freshmen

(Continued from page 35)

find almost steady employment doing odd jobs, and may earn as much as ten to fifteen dollars a week. A few openings may be available for movie or slide projector operators on campus.

Freshman engineers may consult the Office of the Dean of Men for aid in employment or information about jobs and scholarships to help finance their education. Mr. Culver Smith, Employment Counselor for Men Students, has his office in Room 143 Edmund Ezra Day Hall. Incoming freshmen are advised to plan on earning a minimum of expenses during the first year, and to remember that jobs may be secured more easily and maintained more successfully after they become sophomores.

In an attempt to provide necessary financial aid to incoming Cornell Freshmen, the University has established a new program of priority part-time employment. This year's program is a pilot program, the results of which should lead to a future expansion of priority job facilities. Applicants are selected from freshmen applying for scholarships and expressing an interest in part-time work under the program.

Job priority plan procedure includes sending a letter to all scholarship applicants, introducing the program to them. The prospective student then informs the University of what types of jobs he has held and the kind of work he would be interested in at Cornell. The applicant is sent a regular application form to make him aware of college expenses and to provide him with the background of the job plan.

If a student is found to be qualied after screening, the University will arrange interviews for him with employers so that when the student arrives in Ithaca, he may go directly to the employer with a recommendation. Freshmen are not committed to a particular job before they arrive, but rather are directed as much as possible toward a job meeting individual requirements of study time, schedule commitments, need, and preference.

Major types of priority plan jobs include work in University libraries, residential halls, and fraternities. The program is designed to cultivate new jobs by opening new areas for student employment that would not disrupt work opportunities for students already in school. The screening process and counseling activities prior to recommendation will reduce student rejections and turnovers to a minimum.

This year, the University is attempting to place about fifty boys to determine the effectiveness of a priority job plan. The selections will be made strictly on the basis of need, applicants being eligible whether or not they have received a scholarship. Administered by the office of the Dean of Men in cooperation with the Admissions Office, Employment Counseling Office, and the Financial Counselor, the priority job program will make it possible for more freshmen to supplement their incomes at Cornell.

IRC WINDING SKILL OFFERS REALISTIC SAVINGS TO INDUSTRY

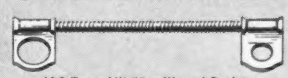
. . . another reason why engineers specify IRC Resistors

Savings in the initial cost and assembly of component parts are an increasingly important factor to electronic engineers. That's why they depend upon IRC for their resistor requirements. IRC's mastery of winding wire elements—dating back more than 25 years—today provides a wide variety of unique units that offer realistic possibilities for savings.

BASIC TECHNIQUE

Wire element is uniformly and tightly wound on an insulated core. Axial leads or other terminations are secured to element by automatic machinery. Insulated housing may be used or omitted.

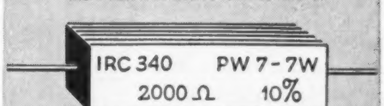
SPECIFIC EXAMPLES



IRC Type AW Wire Wound Resistors

IRC Type BW Insulated Wire Wound Resistors

IRC 4-watt Insulated Power Wire Wounds



IRC 7 and 10 watt Power Wire Wounds

IRC

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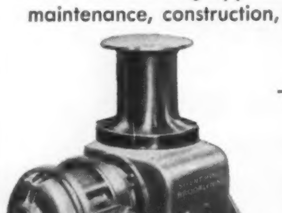
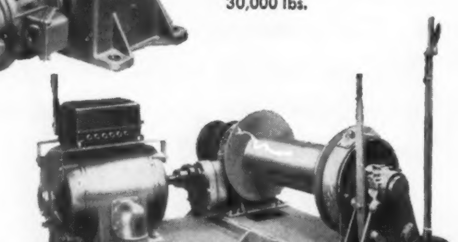


CAPSTAN *6 Sizes:*	DRUM WINCH *4 Sizes:*
Draw Bar Pull Capacities	
2,000 lbs.	6,000 lbs.
6,000 lbs.	12,000 lbs.
12,000 lbs.	24,000 lbs.
18,000 lbs.	40,000 lbs.
22,000 lbs.	
30,000 lbs.	



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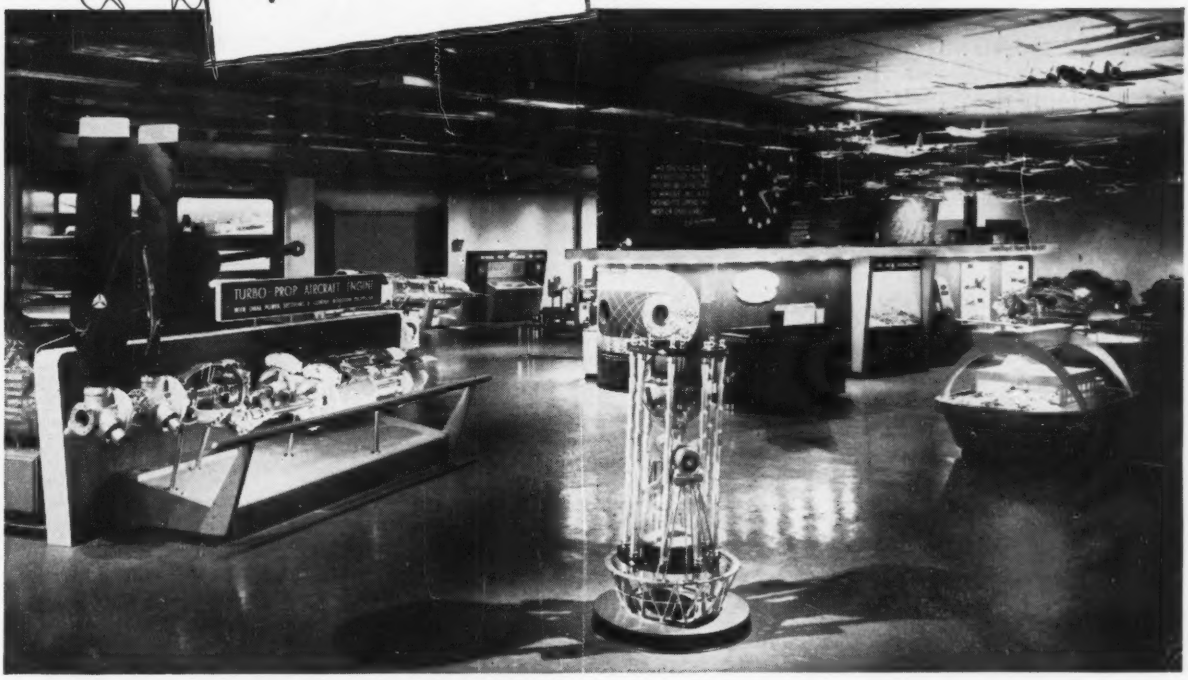

● College Engineering groups—large or small—are invited to visit the Allison POWERAMA in Indianapolis, Indiana.

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You can spend hours in the big display room and enjoy every minute of it. For instance . . .

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Or, you can push a lever and start a model jet plane on its flight and see how much fuel is required for take-off and flight.

Too, you can sit in a bucket seat and actually put a General Patton tank through its paces on a giant-sized turntable.

There are dozens of moving and "talking" displays . . . displays like the working model of a portion of the Allison bearing plant—the world's only fully automatic steel-backed bronze bearing foundry.

These few highlights give you an idea of the scope of the POWERAMA. Class groups or technical societies especially are invited to schedule a visit to the POWERAMA. Requests should be made in writing to: POWERAMA, Allison Division, General Motors Corporation, Indianapolis 6, Indiana.

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Technibriefs

A "bean-size" germanium photocell so versatile it can regulate domestic or industrial heating devices or seek out industrial targets for guided missiles has been developed by a General Electric scientist.

The new electric eye, only slightly thicker than a pencil lead and just three-eighths of an inch long, is more sensitive to light than vacuum photocells one hundred times larger. Its acute sensitivity to infrared radiation makes it ideally suited to the regulation and monitoring of various flames and heating devices.

The unit, still in the developmental stage, has a comparatively large power output that should make it extremely useful in many industrial applications. This high power production makes it suitable for operating relays directly, to control many production processes.

In contrast, power developed by selenium and vacuum cells must be amplified before such cells can operate most relays used in industrial controls.

Because of its power output, the new germanium device could be used for counting, sorting and measuring applications. It could, for example, be employed to reject underfilled containers moving past it on a production line.

This magic eye also could serve in military and civilian roles as a substitute for a Geiger counter and similar atomic radiation detection devices. When nuclear particles penetrate a germanium wafer inside the cell, a current is produced. This current, when slightly amplified, can set off light and sound warning apparatus.

The photocell is extremely simple in design, consisting of a metal cartridge housing a glass lens and a germanium wafer, in contact with a metallic button of indium. A whisker links the wafer to an outside lead.

Detects Hydrogen in Steel Process

An analytical process which shows promise of being fast and accurate enough to study hydrogen during steelmaking has been developed by U.S. Steel Corporation. The appartus consists of a closed system of glass tubes with mercury cut-offs to control the gas flow, an induction furnace, two mercury diffusion pumps, a McLeod gage, a conductivity cell and a vacuum pump to extract air from the system. Conductivity is measured by an ammeter which, with the conductivity cell, is tied into an electrical thermal conductivity bridge activated by four dry cells.

A steel sample is placed in the evacuated induction furnace and fused with pure tin. Mercury vapor in the diffusion pumps forces the gases into a chamber of known volume. They are then conducted into a McLeod gage which measures the gas pressures. To eliminate stratification, the gases next pass through a mixed chamber, from which they enter the conductivity cell. The bottom section of the cell is made of pyrex tubing with a closed bottom and a ground joint on the top. A thin piece of platinum wire is suspended in the cell from nickel wire supports which are welded to the tungsten rods used to conduct the current into the cell. Elecrical leads from the modified Wheatstone bridge circuit are attached to the tungsten rods. The cell is maintained at 0°C by immersion in an ice and water bath.

The current is turned on and the bridge circuit balanced with the platinum wire held at 25°C. The ammeter reading, indicating the amperes necessary to hold that temperature, is a measure of the thermal conductivity of the gas mixture in the cell. This reading is then compared to a calibration previously prepared by using gas mixtures containing various known percentages of hydrogen. The comparison gives an accurate analysis of the hydrogen present in the mixture.

Another Step in Color TV

Production of RCA's first commercial color television sets began at Bloomington, Indiana, March 23. RCA plans to manufacture during 1954 about five thousand each of 15-inch and 19-inch color receivers. Shipment of the color sets commenced in early April. Deliveries have gone to RCA distributors in areas where network color signals can now be received. Already color reception is possible in 35 large cities, and it is estimated that by the end of 1954, one hundred twenty-five TV stations will be equipped for color broadcasts.

RCA also plans to expand color programming over the National Broadcasting Company network. By the end of this year, NBC will be colorcasting two programs a week from New York and a third program from Burbank, California. In addition, NBC will present a series of specially produced ninety-minute shows, beginning in October.

Chemical Milling Process

Precision milling of aircraft and guided missile parts without machinery has recently been accomplished with a new chemical milling process developed by North American Aviation to save weight, give greater accuracy and permit better designs.

Usable by military and civilian industries, the chemical milling method removes unwanted metal from complex or fragile formed parts without danger of warpage or rejection that might result from ma-

WAX WORKS . . .

Until a few decades ago, the principal users of wax were the candlestick makers. Today's diversified demands for wax put it in the class of modern industrial miracles.

Go into a super-market . . . see how wax works in the packaging and protection of milk and dairy products, cereals, bake goods, frozen foods. Think of its use in drug and cosmetic products . . . cups, crayons and carbon paper . . . polishes, preservatives and paper matches . . . And the number of industrial applications defies accurate calculation.

TOO BIG FOR BEES . . .

The ancients knew the physical properties of wax . . . and bees supplied the raw material. What then spurred this century's growth in production to more than a half-million tons a year?

The answer lies partly in the petroleum industry's desire to find more profitable applications for one of its products . . . partly in the desire of other industries to improve their processes and products.

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chining. The method is equally effective in making intricate cuts and in tapering metal.

Chemical milling is not intended to replace all machining operations but to permit new, unconventional designs. Cost of chemical milling equipment is only a fraction of that for a skin mill.

Stiffened construction of wings or fuselage is possible by this method, allowing cooling or heating passages, if needed. A design similar to the "sandwich" or "waffle" construction can be produced without the previous headaches of machine-formed complex curves and angles.

To prepare a part for chemical milling, the metal to be removed is left exposed, while the rest of the part is masked with a specially developed coating. The entire part is submerged in an etching solution. The solution attacks exposed surfaces evenly at a constant rate until the desired amount of metal has been etched away.

Electronicall controlled, the chemical sculpturing process produces finished metal surfaces to accuracies of two-thousandths of an inch.

Added to making possible broader horizons of design, chemical milling can lead to faster production of complex parts. With a solution tank large enough, any number of parts can be etched at the same time, greatly reducing unit costs.

While most of the experimental work with chemical milling has been done with aluminum, the process has also been applied to steel, stainless steel, titanium, and other metals.

New Tube Made of Fused Quartz

GE's Lamp Division has developed a revolutionary new infrared lamp, tubular in shape and slightly larger in diameter than a cigarette. Rather than regular or heat-resistant glass, the tube is made of fused quartz. Producing more than four times the energy concentration delivered by the standard 250-watt infrared bulb, it can withstand high temperatures and the shock of violent temperature changes. The heating element is a coiled tungsten filament.

The advantages of the new lamp include the following: higher energy concentrations in a small space—100 watts per lighted inch of tube length—than have been possible in the past; lightness—the 500-watt size weighs three-quarters of an ounce and the 100-watt size, seven eighths of an ounce; little maintenance—it has a rated trouble-free burning life of more than 5000 hours.

The physical properties of fused quartz — its high mechanical strength, low coefficient of expansion, high melting point, superior insulating properties, and resistance to acids and thermal shock—contribute greatly to the lamp's versalility.

The new lamp is expected to be applied as the heating element in industrial radiant drying and baking ovens, in home cooking ovens and ranges, in house-heating equiment, and in multifarious home appliances. Additional uses include the heat processing of farm crops and seeds, thawing of frozen pumps, milkhouse heating, and others.

Vacuum Tubes Now Sliced

Slicing glass vacuum tubes just like salami—to make sure they'll perform right in radios and TV sets—is all in a day's work for General Electric tube engineers.

Slicing up tubes is part of a checking program which follows them from arrival of raw materials to shipment of the finished product.

The slicing technique is especially striking, since it solved a problem which could rank in reverse with Houdini's man-in-the-bottle trick.

Engineers needed a way to get inside a tube's glass exterior and inspect its inner parts without disturbing them. They had to check spacing and alignment tolerances of thousandths of an inch in the completed tube. If these varied, a radio or TV set with similar tubes might act up.

Earlier checking methods never satisfied the engineers. Breaking open the glass and cutting out the parts for study could move or distort them and spoil the test.

Then one engineer, who'd seen a flower encased in clear plastic, suggested the slicing procedure.

First, the tube is immersed in clear, liquid plastic. Then its submerged glass tip is cracked off with pliers. Since there's a vacuum inside the tube, normal atmospheric pressure forces in the liquid plastic to fill the tube completely.

Chemical action and baking harden the plastic in about two hours, with the tube parts undisturbed. Engineers then crack away the glass tube exterior and slice the plastic-encased parts into quarter-inch-thick sections for study under a microscope.

New Paving Machine Developed

Concrete paving without road forms has become a reality with the introduction of a self-propelled formless paving machine that can lay better than 1,000 linear feet of slab daily.

Used experimentally on an 18,000-foot stretch of road in southern Illinois, the machine required a crew of only 11 men, as against the 32 to 33 that would have been needed with ordinary paving methods.

The rig, adjustable to handle slabs 18 to 26 feet wide and of any normal thickness, travels on a pair of 13-foot crawlers. Forms 2 feet long extend ahead of the rig to confine concrete deposited on the subgrade by a dual-drum mixer. A surface vibrating screed (piece that levels off the concrete) extends across the machine; it consists of two 2x10 inch planks set on edge and carrying an electric vibrator in the center. Reciprocating transverse screeds are mounted four feet fore and aft of the vibratory screed.

As the rig advances, the mix is struck off by the first reciprocating screed, consolidated by the vibratory screed, and finished to final grade by the second reciprocating screed. The rig is powered by a 140-hp engine.

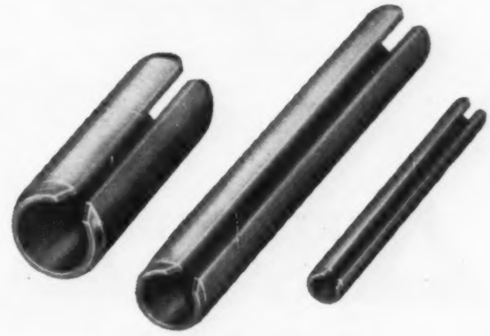
It is not difficult for the machine to maintain alignment. Maneuverability of the crawlers makes it easy for the operator to match a wire pointer on one form with a string line staked on the grade. However, it is imperative to have a smooth stretch of subgrade finished to the proper elevation if the paver is to lay a slab of correct thickness and at the correct grade. On the experimental piece, the subgrade was prepared by motor graders, whose operators had to exercise extreme care to obtain minute accuracy.

self-locking fasteners

Elastic Stop nuts

Every major aircraft now being assembled relies on the vibration-proof holding power of ELASTIC STOP nuts. Only ESNA manufactures a complete line of all types and sizes of self-locking nuts.

Rollpins



dia. from 1/16" to 1/2"

Rollpins are slotted, tubular steel, pressed-fit pins with chamfered ends. They drive easily into holes drilled to normal tolerances, compressing as driven. Extra assembly steps like hole reaming or peening are eliminated. Rollpins *lock* in place, yet are readily removed with a punch and may be reused.

Cut assembly costs by using Rollpins as set screws, positioning dowels, clevis or hinge pins. Specify them in place of straight, serrated, tapered or cotter type pins.

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AIR CONDITIONING

Frick Company recently completed the engineering and installation of a year 'round comfort air conditioning system for the new office annex of the Fairchild Aircraft plant in Hagerstown, Md., where they manufacture their famous C-119 Flying Boxcars.

The cooling load of 245 tons of refrigeration is carried by two Frick "ECLIPSE" 9-cylinder high-speed compressors.

For the latest in air conditioning and refrigeration engineering and equipment, look to Frick Company, now in its second century of service to business and industry.

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DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA. U.S.A.

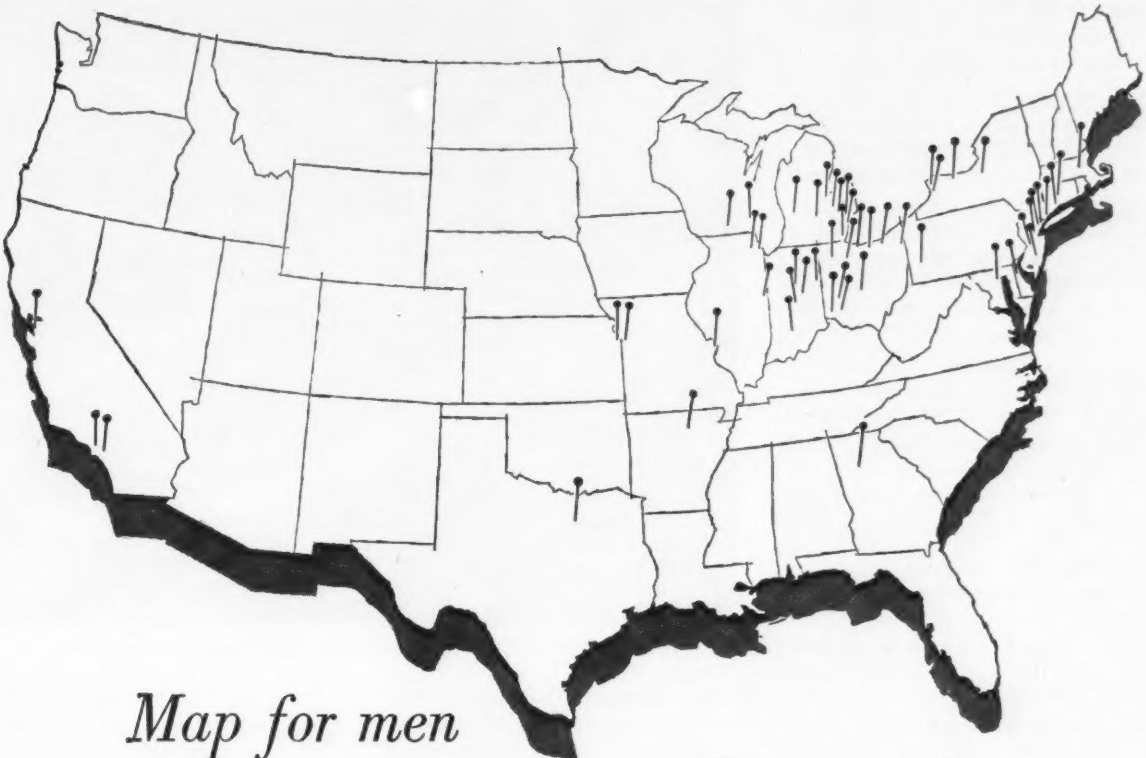
Equity

(Continued from page 16)

is some question, however, as to what constitutes a "palpable" mistake. It is universally granted that actual knowledge of the bidder's mistake is within the meaning of palpable mistake. Moreover, there is a growing tendency to raise an inference of *palpable mistake* if there is reason to believe the party must have or should have had knowledge or suspicion of the mistake. It is well to note that palpability of the mistake is a question decided by the court and upon which the case is likely to turn. The counsel for the mistaken bidder must convince the judge of the palpable nature of the mistake. Since judges in general have little or no background in matters of construction and estimation, it is often necessary to introduce evidence and testimony of a somewhat technical nature. The engineer may be called upon to testify or to prepare reports showing the reasons for the discrepancy, the deviations of the bid from other bids for the same project, the recognizable character of the error to public works or private construction experts, or the stage in planning where the mistake was likely to have become apparent. Customary business procedures may be presented to the court for consideration in establishing the standard of conduct to be applied. A statistical study of percentage variations in bids for various ranges of project costs has been published in *16 Minn. Law Review* at page 137 et seq. It suggests the percentage deviations from the average bid which might be considered palpable mistake, and concludes that such data has been adhered to by the courts, though in many cases the decision was arrived at by other methods. The article further suggests the judicial relief for palpable mistake in bidding is warranted as a matter of policy because experience indicates that poor workmanship and shoddy materials are often the result of unrelieved hardship cases.

The situations which have been discussed deal with the avoidance of contractual obligations which have become operative by the execution of a signed writing. This is accomplished by making the contract voidable, that is, permitting a mistaken party to be released from his obligation. A similar treatment is now given under certain circumstances to the withdrawal of bids after the bid bond has been furnished, but before the definitive contract has been signed. The case of *Union & People's National Bank v. Anderson-Campbell Co.*, 256 Mich. 674 (1932), is illustrative. The contractors had made an innocent and not grossly negligent error in omitting certain materials when preparing their bid. The error was discovered after the bids were opened but before acceptance. They were permitted, upon prompt notice, to withdraw their bid without forfeiture of the bid bond. Fortunately for the contractor, neither the city nor third parties were prejudiced thereby. The court treated this legal action to recover the deposit as equivalent to a bill in *equity* for cancelation of the bid for mistake. Note that in the situation the mistake was not palpable, but the equities

(Continued on page 50)



Map for men

going places!

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GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan

Chemicals

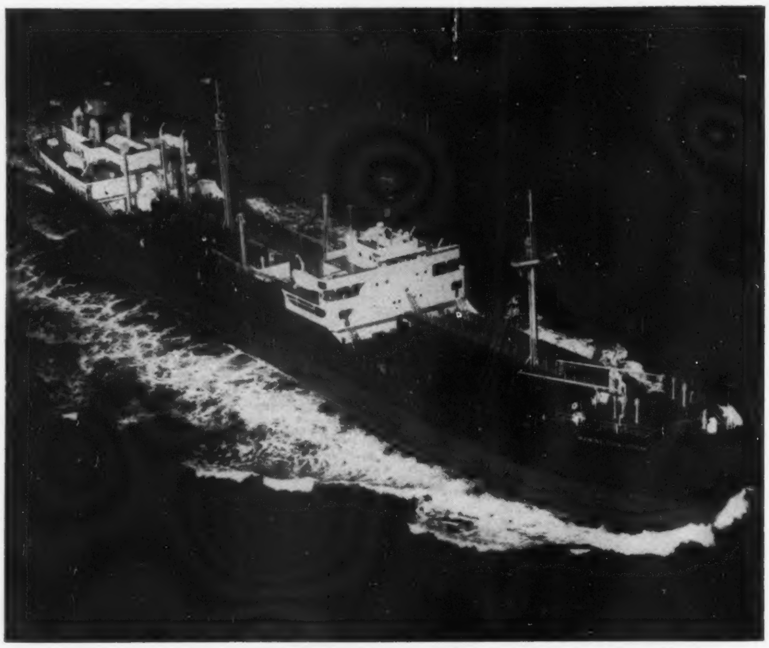
(Continued from page 11)

Tank truck transportation allows the movement of chemicals in bulk liquid form instead of the usual flake or lump form, thus eliminating the cost of packaging and remelting. Molten sulphur and phthalic anhydride are shipped in heavily insulated trucks, equipped with heating coils to melt the product in case unexpected delays cause soldification.

Tank trucks also carry refrigerated products like chlorobutadiene, which is loaded at -15°F and has a critical temperature of 0°F; these special tank trucks are insulated with a phenol formaldehyde resinous lining.

Transportation on the Water

The growing practice of the chemical industry to locate plants on the banks of waterways suggests a relatively new but important means of transporting chemicals. Shipping by barge and boat offers a cheap means of shipping bulk chemicals and raw materials. The vast river system that connects the Great Lakes with the Gulf provides a convenient highway over which chemicals can be moved cheaply.

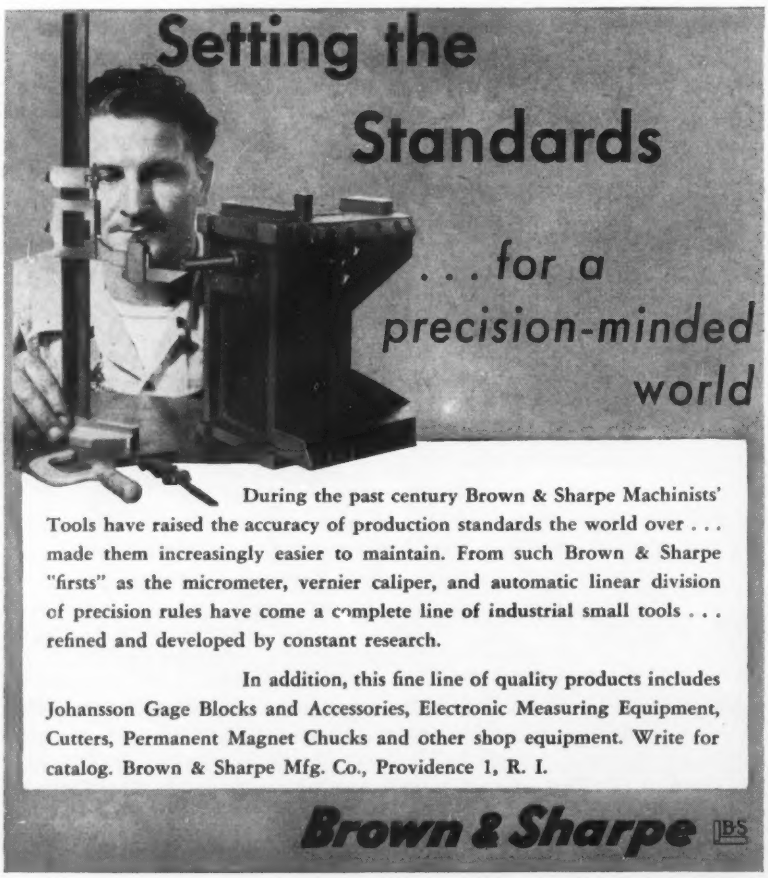


Aerial view of a Marine Dow-Chem cargo ship.

Most inland shipping on waterways is carried by barges. Individual barges handling loads up to 500 tons offer the chemical industry a flexible and economic means of transportation. Up to now, large quantities of sulfur, sulfuric acid, acetic acid, caustic soda, HC1, ethyl ethers, butane, propanes, NH_3, and Cl_2 have been shipped in this way. Over 10 million tons of chemicals have been shipped by barge in the past year.

Use of the integrated barge fleet makes delivery costs even lower. In this system the barges and towboats are fitted together to form, in effect, a single vessel of unbroken hull line. The end barges have one square end and one shaped end, while the others have two square ends. Putting these barges together with the towboat in the rear reduces running resistance and allows faster towing with less power. Of course, this type of fleet can not be used where locks are encountered.

In practice, three types of containers are used to accommodate all normal cargoes. The first is the standard bulk liquid cargo barge with the vessel itself acting as a large container. The second is the double skin type with the compartments built clear of the skin of the vessel. Also used are barges constructed with built-in cylindrical



tanks.

Great care must be taken in selecting a barge for use with a particular chemical. Experienced chemical engineers and transportation experts must be consulted. The materials of construction depend on the type of chemical to be shipped. Stainless steel, rubber-lined, glass-lined and plastic tanks have been necessary. Provision is also made for fluids under pressure by building extra strength into the tanks. For some uses temperature control is necessary. Here insulation and heating coils must be provided.

Pumps, valving, and venting arrangements are also important factors. Shore facilities must be considered when specifying these items. Good planning can greatly reduce loading costs.

All shipping, of course, must receive the endorsement of the Coast Guard. Rigid rules have been set up to provide for complete safety on the waterways. By meeting these requirements, cargoes have been shipped with pressures ranging from 5 to 300 psi. Other cargoes require temperatures up to 400°F and down to -20°F; tanks are lagged with six inches of fiberglass insulation to prevent heat loss, and steam coils may be provided to allow heating at terminals. All shipments must be inspected and checked for safety, and licensed men must remain on hand at all times to supervise operations.

A novel approach to the problem of providing cheap transportation is the use of ships to carry truck trailers. An east coast company has plans to build four 650 feet, 20-knot ships, large enough to transport 240 trailers. By means of elaborate docking facilities, the trailers will have direct access through the stern to the two enclosed ships' decks. A complete loading and unloading cycle takes only four hours because handling of individual cargoes is eliminated.

Also gaining in importance is the use of ocean-going vessels built especially to transport chemicals. An example of this trend is the newly commissioned S.S. Marine Dow-Chem, a ship designed to move 73% caustic soda and other corrosive liquid chemicals. This ship has a built-in cathodic protection in its hull. Magnesium anodes are installed in the hull to provide sacrificial protection from corrosion. This tanker also provides for heating the tanks to prevent the 73% caustic from solidifying. Moreover, this heat also increases corrosive action, and additional precautions must be taken by using tanks of nickel clad steel.

Comparative Summary

The bulk movement of chemicals makes possible many economies in processing and handling, and also eliminates the use of containers and the payment of freight on the weight of the containers. The shipper, however, chooses his freight service according to availibility, speed , safety, and cost.

Since the highways have followed the reorientation of the nation's industrial centers and the railroads have not, tank truck service is more readily available and is more flexible. However, since railroads serve more communities than canals and navigable rivers, the railroads have the edge in availability over waterway traffic.

The railroads theoretically are capable of matching the trucks in speed of service and actually gain an edge as the length of the haul is increased. However, a commodity shipped by tank truck service is exposed to fewer handlings and fewer relays than on the rails. Shipment by waterways is usually the slowest form of freight hauling. Nevertheless, this is the cheapest method of transportation.

By combining two methods of hauling, it is possible to incorporate the advantage of each. One innovation along this line is the trailer-on-flatcar service where loaded truck trailers are carried on railroad flatcars, and truckers on both ends of the line handle the pickup and delivery. Since the rails' line-haul costs less and trucks can pick up and deliver more cheaply, the combination of the two benefits the railroads, truckers, and shippers.

The use of modern technology and more practical innovations can provide methods for cheaper and more efficient transportation. Only by the cooperative effort of the shipper and the carriers can the industry get the best possible transportation for its dollar.

Welded Steel Designs Cost Less Because:

1. **Steel is 3 times stronger than gray iron.**
2. **Steel is 2½ times as rigid.**
3. **Steel costs a third as much as iron.**

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IMPROVES APPEARANCE SIMPLIFIES PRODUCTION CUTS COST

YOUR success as a designer depends on your ability to keep costs down on products you design. By properly applying the principles of welded steel construction, cost of manufacture can be reduced substantially because material costs are less, actual production is simpler. In addition, the product is stronger, more rugged, has modern appearance.

The examples show how one designer has applied the principles of welded steel to a machine base. The sturdy box-type construction of the steel design eliminates weight because of steel's greater strength and rigidity. Considerable machining, cleaning and finishing of former castings has been eliminated. More modern in appearance, nevertheless, the steel design costs 15% less to produce.

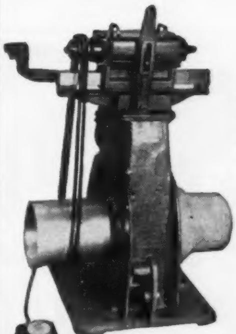

Fig. 1—Original Design *of wire straightening machine. Required considerable machining, cleaning and finishing prior to painting.*

Fig. 2—Welded Design *costs 15% less. Has improved appearance . . . better selling appeal. Tests show base has greater rigidity than in original construction.*

IDEAS FOR DESIGNERS

Latest data on designing machinery for welded steel construction is available to engineering students in the form of bulletins and handbooks. Write:

THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio

THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

Equity

(Continued from page 46)

favored the contractor and so relief was granted.

Substantial Performance

Among other engineering applications of this type of judicial consideration are actions for substantial performance in which the contractor is unable to fully perform his job for a bona fide hardship reason (labor strike makes it impossible to get workmen; essential materials restricted by government under emergency conditions) but is entitled to payment for that part of the work which has been satisfactorily completed. Equity here considers (1) the hardship circumstances, (2) the unjust enrichment or unconscionable advantage of the owner, and (3) the prejudicial position of interested parties if relief is granted.

Another example of equitable action might be to compel the specific performance of a job by a subcontractor. Assume that the general contractor has contracted with the owner to use a certain type of waterproofing material which can only be obtained from one particular subcontractor. If the sub has agreed to supply that product but later refuses to continue shipment, an order for specific performance may be obtained to make him supply the necessary quantities.

Much of the difficulty which has been experienced with extra work clauses can be relieved by the courts of equity. The strict legalistic approach tends to disregard or deal harshly with such clauses. The reason is that the promise for extra money is often not supported by sufficient consideration because one cannot offer as consideration that which he is already legally bound to do. Simply stated, the contractor is obliged to do the job, the unforeseen difficulties which create extra work are included in that obligation to complete the job. The courts may alleviate this condition by finding somewhat subtle forms of legal consideration. The writer is unable to present authoritative information as to the equitable treatment of extra work clauses but believes that such treatment can be anticipated as the modern equity-

(Continued on page 52)

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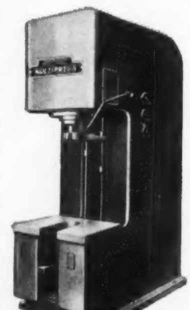
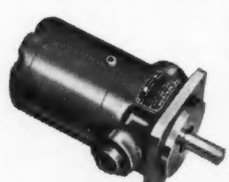


The truck of the car—minus wheels and axle—is mounted on a Denison hydraulic Multipress. The press ram raises and lowers the truck, simulating up-and-down riding characteristics. In 30 days, the springs and snubbers get the equivalent of 10 years' wear on the road.



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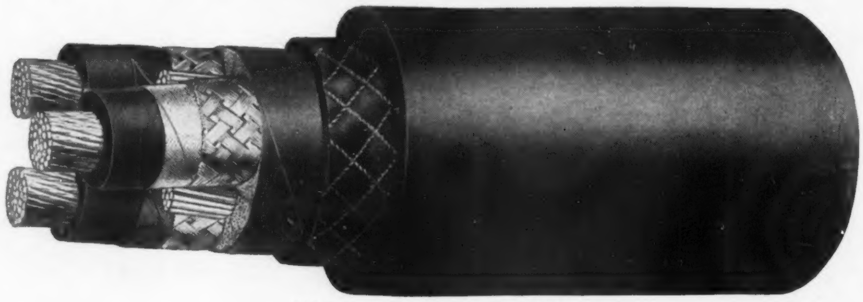

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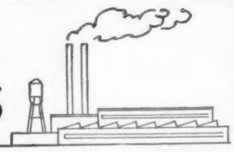

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Facts about Fafnir

Fafnir's five New Britain plants contain nearly 22 acres of floor space.

The most complete line of ball bearings and power transmission units in America. The Fafnir Bearing Company, New Britain, Conn.

Equity

(Continued from page 50)

law blended jurisprudence develops.

Summary

The object of this writing is not to create in the construction engineer a complacent attitude toward his work—equity will not be a crutch for negligent workers and careless estimators. But it is significant to recognize that developments in American jurisprudence through the equity courts are alleviating certain harsh and rigorous tenets of the common law which more or less directly affect technical projects. Examples of these effects have been given; no doubt many other applications, extending into other technical matters have been and shall continue to be encountered. As the number of these illustrations grow there is an increasing likelihood that legislation will eventually be passed to give to these problems a just and businesslike interpretation. In the meantime, equity may be a highly useful tool to the construction outfit faced with an honest hardship problem.

Austin Bush, Rensselaer, '50, Helps Develop New Pump

AUSTIN BUSH, inspecting stuffing box assembly on boiler feed pump.

Reports interesting project engineering assignments at Worthington

"Despite its size as the leading manufacturer in its field," says Austin Bush, "I have found Worthington pays considerable attention to the interests of the individual. The company's excellent training program consists of several months of working with the various types of equipment manufactured, augmented by technical lectures, and talks on the organization of the corporation.

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"Opportunities for advancement are good, and pleasant associates make Worthington a fine place to work."

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FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, New Jersey.

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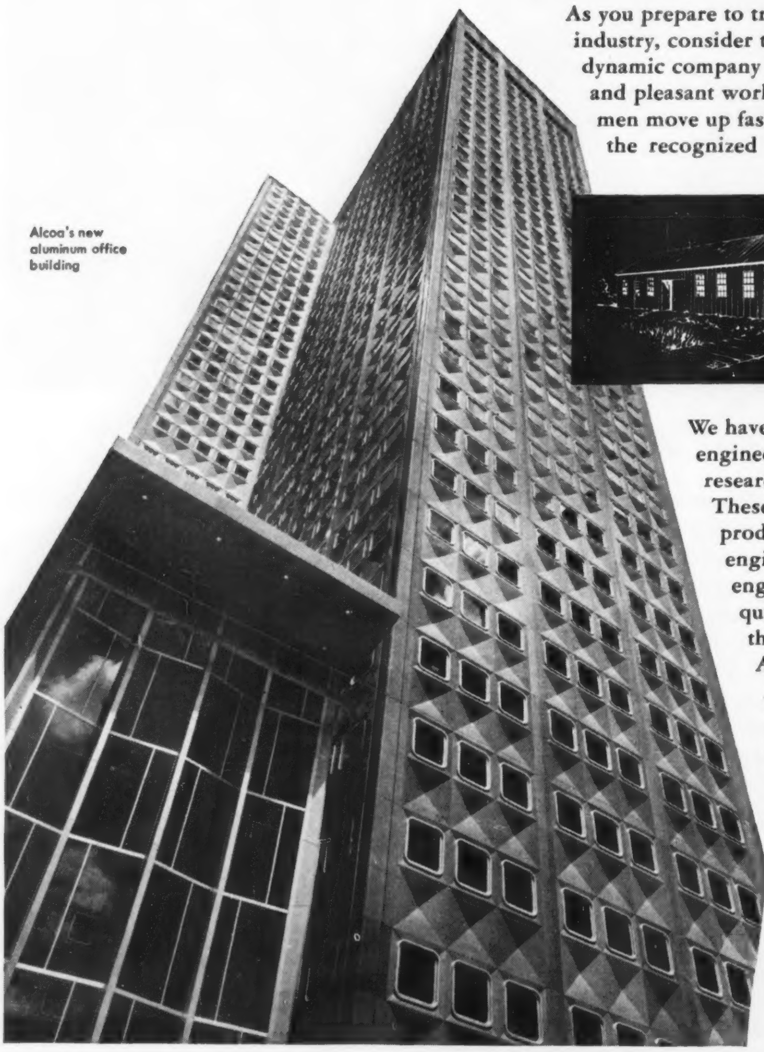
THE ALUMINUM INDUSTRY WAS BORN ON SMALLMAN STREET

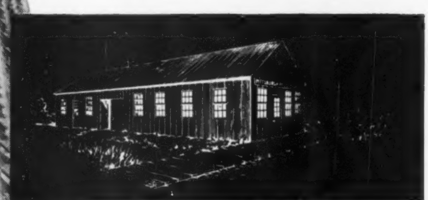
▼ In 1888, the aluminum industry consisted of one company—located in an unimpressive little building on the east side of Pittsburgh. It was called The Pittsburgh Reduction Company. The men of this company had real engineering abilities and viewed the work to be done with an imagineering eye. But they were much more than that. They were pioneers . . . leaders . . . men of vision.

A lot has happened since 1888. The country . . . the company . . . and the industry have grown up. Ten new territories have become states, for one thing. The total industry now employs more than 1,000,000 people—and the little outfit on Smallman Street? Well, it's a lot bigger, too—and the name has been changed to Alcoa. ALUMINUM COMPANY OF AMERICA . . . but it's still the leader—still the place for engineering "firsts".

As you prepare to trade textbooks for a position in industry, consider the advantages of joining a dynamic company like Alcoa—for real job stability and pleasant working conditions—where good men move up fast through their association with the recognized leaders in the aluminum industry.



Alcoa's new aluminum office building



We have fine positions for college graduate engineers—in our plants, sales offices and research laboratories from coast to coast. These are positions of responsibility in production supervision, plant and design engineering, industrial research or sales engineering. Right now it may be quicker than you think from a seat in the classroom to your career with Alcoa. Why not find out?

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ALCOA ALUMINUM

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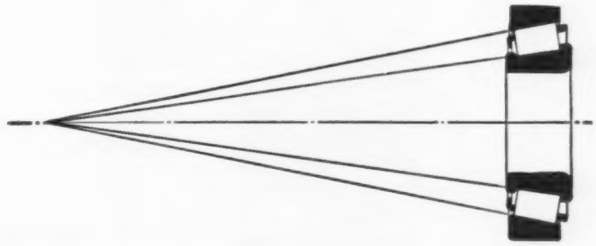
As you see here, all lines drawn coincident with the working surfaces of a Timken bearing meet at a common point on the bearing axis. This means Timken bearings are designed to give true rolling motion. And, since they're tapered they can take radial and thrust loads in any combination.



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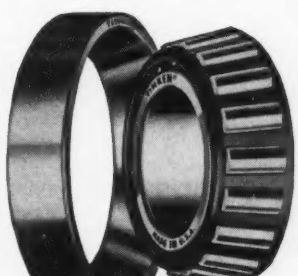

Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

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STRESS *and STRAIN...*

A bored cat and an interested cat were watching a game of tennis.

"You seem very interested in tennis," said the bored cat.

"It's not that," said the interested cat, "but my old man's in the racket."

* * *

One of the questions asked in an examination on stockraising was, "Name four different kinds of sheep."

An inspired student answered "Black sheep, white sheep, Mary's little lamb, and hydraulic ram."

* * *

An Engineer is said to be a man who knows a great deal about very little and who goes along knowing more and more about less and less until finally he knows practically everything about nothing. whereas,

A Salesman, on the other hand, is a man who knows very little about a great deal and keeps knowing less and less about more and more until he knows practically nothing about everything.

A Purchasing Agent starts out knowing practically everything about everything, but ends up knowing nothing about anything, due to his association with engineers and salesmen.

* * *

We can understand why so many fathers worry about their sons—they used to be one themselves.

* * *

At the stroke of twelve, the irascible father stomped to the head of the strairs and shouted. "Young man, haven't you got a selfstarter?"

Young man: "Don't need one as long as there is a crank in the house."

* * *

Waiter: (To customer eating soup): "May I help you, sir?"

Diner: "What do you mean, help me? I don't need any help."

Waiter: "Sorry, sir. From the sound I thought you might wish to be dragged ashore."

Who says the Russians have no sense of humor? Here's a joke that is currently rolling them in the aisles in Moscow.

Ivan: "Kto bula dama, a kotoroi ya videl bac, vchera yecherom?"

Boris: "Obe Net dama—ona moya zhenya."

* * *

The waitress was wondering why the elderly man was eating while his wife was staring out the window.

"Aren't you hungry?" asked the waitress.

"Sure am," was the reply, "I'm just waiting till Paw gets through with the teeth."

* * *

"I can't marry him, Mother, he's an atheist and doesn't believe there is a Hell."

"Marry him anyway, my dear, and between the two of us we'll convince him."

* * *

"Isn't he rather fast for you, Bev?" "Yes, he is, but I don't think he'll get away."

* * *

An old gent was passing a busy intersection when a large St. Bernard ran by and knocked him down.

A moment later, a Crosley car skidded around the corner and inflicted further damage. A by-stander helped him to his feet, and someone asked if the dog had hurt him.

"Well," he answered, "the dog didn't hurt so much, but that tin can tied to his tail nearly killed me."

* * *

Daffynition:

Tree: A solid thing that stands in one place for 50 years and then suddenly jumps in front of a woman driver.

* * *

Roadside sign: Slow down—before you become a statistic.

The scene is a train compartment in Romania. The characters: A Russian officer, a Romanian, an old lady, and an attractive girl.

The train enters a tunnel. The passengers hear first a kiss, then a vigorous slap.

The old lady thinks: "What a good girl she is, such good manners, such fine moral character!"

The girl thinks: "Isn't it odd that the Russian tried to kiss the old lady, and not me?"

The Russian thinks: "That Romanian is a smart fellow; he steals a kiss and I get slapped."

The Romanian thinks: "Am I a smart fellow! I kiss the back of my hand, hit a Russian officer, and get away with it."

* * *

"I guess I've lost another pupil," said the professor, as his glass eye rolled down the kitchen sink.

* * *

Teacher: "Willy, what is the shape of the earth?"

Willy: "It's round."

Teacher: "Can you prove it?"

Willy: "Awright, awright, so it's square, I don't want to argue."

* * *

"Look, Mister, just how long is your car going to keep stalling like this?"

"Just as long as you do, Baby."

* * *

Newsboy: "Extra! Extra! Read all about it, two men swindled!"

Passerby: "Give me one—say there isn't anything about two men being swindled in here."

Newsboy: "Extra, Extra! Three men swindled."

* * *

If your girl is the electric type she may be resistant, if she is the magnetic type she may be reluctant.

PHOTOGRAPHY AT WORK—No. 10 in a Kodak Series

Photography took a look

and a harvester got a stronger set of teeth

John Deere engineers, building a new beet harvester, wanted spring-tooth disposal wheels with long life. High-speed movies showed the way.

The disposal wheels on the new John Deere beet harvester moved faster than the eye could see.

So the engineers studied them in action, slowed down by the high-speed motion picture camera. A small difference in design resulted in extra-long life for the spring teeth.

Slowing down fast action is but one way photography helps product design and manufacture. With x-rays it searches out hidden faults in castings, welds, and assemblies. And by photographing cathode ray traces, it discloses the causes of improper operation. These are but a few of the ways photography saves time, reduces error, cuts costs and improves production.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. If you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

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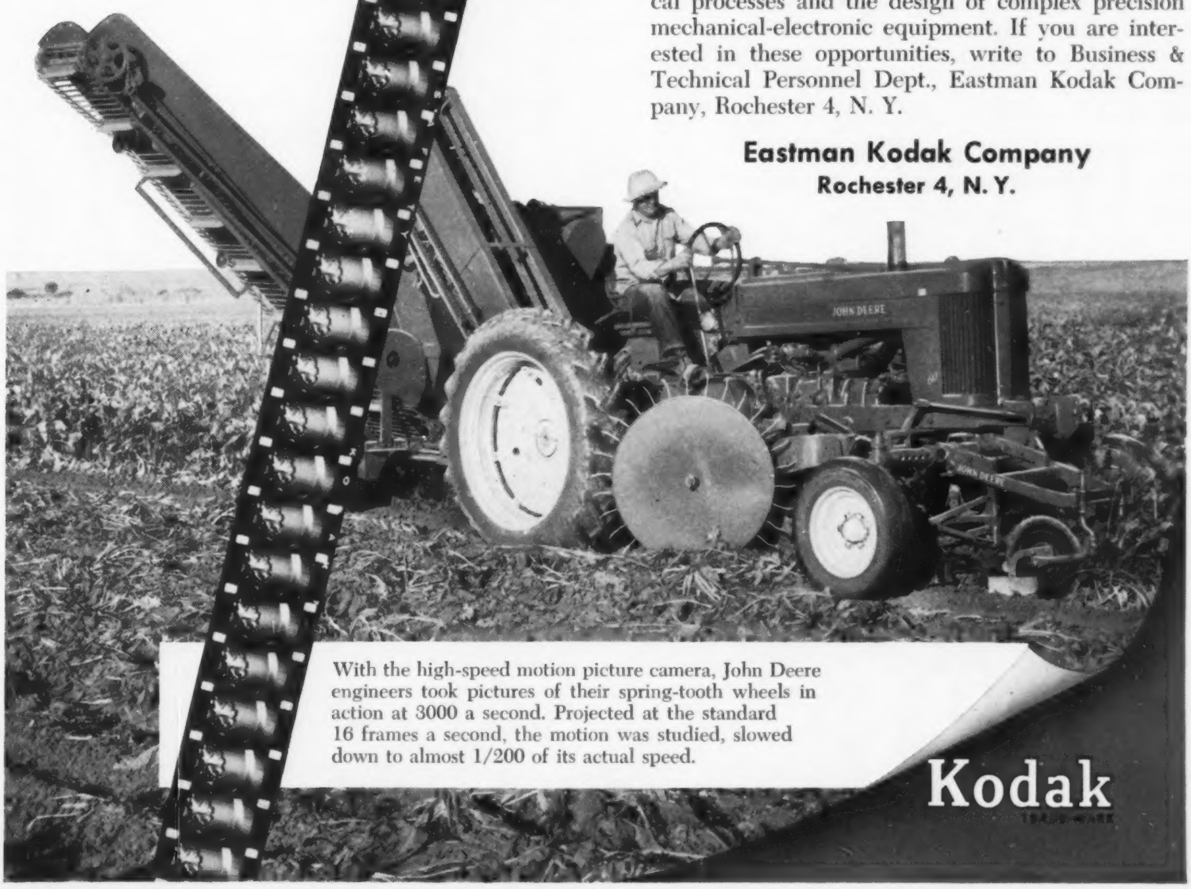

With the high-speed motion picture camera, John Deere engineers took pictures of their spring-tooth wheels in action at 3000 a second. Projected at the standard 16 frames a second, the motion was studied, slowed down to almost 1/200 of its actual speed.

LOOKING AHEAD WITH GENERAL ELECTRIC

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In the next 10 years there will be more opportunity in the electrical industry than in all the 75 years since Edison invented his lamp

THREE quarters of a century after the beginning of the Age of Light, you might think that the Age of Opportunity in electricity had pretty well ended.

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Thomas Edison invented his electric light at age 32.

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